GREATER PHILADELPHIA'S KNOWLEDGE INDUSTRY

Leveraging the Region's Colleges and Universities in the New Economy

Prepared by the Pennsylvania Economy League – Eastern Division

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On behalf of the project's sponsors, I am pleased to present a collection of reports on *Greater Philadelphia's Knowledge Industry*. Our purpose in undertaking this project was to profile the region's colleges and universities, with the goal of gaining a better understanding of this important regional asset and how it contributes to Greater Philadelphia's economic competitiveness. This goal has led to numerous recommendations for strengthening our knowledge industry, including specific strategies that aim to forge stronger ties between our colleges and universities and the regional economy. The ultimate success of this project, however, will be measured by the report's ability to bring together the region's academic, business, civic, and political communities under a shared vision for our region's future.

In completing this project, we have collected a significant amount of data to profile and benchmark Greater Philadelphia's knowledge industry, allowing for regional comparisons that form an important backdrop describing the global competitive environment. Much of this data was obtained from the National Center for Education Statistics (NCES), which maintains a wealth of data on higher education institutions throughout the country in the Integrated Post-Secondary Education Data System (IPEDS). As you will see, the NCES/IPEDS data set forms the backbone of our research. Many colleges and universities in the Philadelphia region also willingly provided data and insight during the research process, an invaluable complement to the NCES/IPEDS data set. Qualitative insight was gathered from notable sources on higher education, in particular the *Chronicle of Higher Education*, the *Philadelphia Inquirer* and the *Philadelphia Daily News* (for local higher education insight), and various academic publications in the fields of public policy, economics, and higher education administration. Finally, a number of individuals representing the academic, business, and civic sectors in the region previewed the draft research findings, providing important feedback on content and presentation.

Thanks and much deserved recognition go to the following organizations and individuals for their help and assistance throughout the project:

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- More than 60 academic, civic, and business leaders in the region took time to preview the draft research findings, providing valuable feedback on content and presentation.
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- Lastly, officials of other regions, most notably Baltimore, Boston, Pittsburgh, and the San Francisco Bay Area, graciously hosted the research team during benchmarking visits and provided valuable insight into their regions' knowledge industry initiatives.

The research presented in these reports represents the collective work of PEL Research Associates Annette Goldberg and Ernie Wright, under the guidance of Executive Director David Thornburgh and Deputy Director and Research Director Steve Wray and with the assistance of Research Associate Andrew Maleson and former Research Associate Anuj Gupta. A copy of the report is available on our website: www.peleast.org. We invite your thoughts on this research – please e-mail, call, or write us with your comments.

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GREATER PHILADELPHIA'S KNOWLEDGE INDUSTRY

Never before has the academic mission of colleges and universities – to generate and impart knowledge – been so fundamentally tied to regional economic success. With the emergence of the new economy, ideas and knowledge are becoming businesses' competitive advantage as traditional business costs are being driven down by technological breakthroughs. Colleges and universities are truly becoming the *knowledge industry* because their primary output is both knowledge and knowledge workers. Understanding the individual and collective nature of our institutions as well as the industry's ties to the regional economy is an important first step in capitalizing on this vital regional asset, especially in the context of comparatively weaker performance of the regional economy.

For years, the Philadelphia region's higher education assets have been touted as leading factors in the future economic success of the region. Yet the region's economic and demographic statistics are disconnected from what should be an important regional advantage. Despite the number of students graduating from the region's colleges and universities, the region is aging and its educational attainment levels are surprisingly low. The region's economy has not seen the growth in new business starts or employment growth that has been characteristic in other knowledge regions, particularly in the booming information technology fields. The question lingers: With its base of educational assets, why has the region underperformed the leaders in these crucial measures of economic competitiveness?

Greater Philadelphia's Knowledge Industry

Greater Philadelphia's 83-institution knowledge industry represents a diverse and accomplished set of colleges and universities. The distribution of the knowledge industry bucks general demographic trends in the region. While much of the region's population and employment base has shifted outward from the city to suburban communities, 40 percent of the student population in the CMSA [1] remains in the city of Philadelphia.

The industry is a major economic player in the region with combined annual spending of $6.4 billion. The largest institutions dominate the industry, with the top four accounting for more than 50 percent of expenditures. As other industries have restructured, our colleges and universities – essentially place-based institutions – have emerged as major regional employers. They stand out as a growth industry and are believed to be the region's top "exporting" industry.

Looking beyond the confines of the metropolitan region, Greater Philadelphia's colleges and universities are at the heart of an extended knowledge region that stretches along the entire East Coast from Boston to the Washington metropolitan area. The northeastern corridor of the Boston, New York, Philadelphia, and Baltimore-Washington regions accounts for four of the seven largest knowledge regions in the country, with over 1.45 million full-time equivalent (FTE) students and nearly $5.2 billion in R&D expenditures.

Industry Contributions to Regional Economic Competitiveness

The region's knowledge industry boosts regional economic competitiveness beyond traditional notions of economic contributions by:

Attracting People to the Region – With FTE enrollment of 213,400 (296,000 full- and part-time students) and 27,000 faculty, Greater Philadelphia's knowledge industry ranks seventh in the country in FTEs. An estimated one-quarter of newly enrolled students (between 18,000 and 19,000) come from outside the region for school each year. In terms of newly enrolled freshmen, there is an estimated net gain of 3,000 college-bound individuals to the region (comparing total new enrollment with regional high school seniors planning to go to college). National rankings of our institutions collectively rank the region 8th in the country, with the region's reputation largely resting on the shoulders of the University of Pennsylvania and a set of premier liberal arts colleges and smaller universities.

Creating Access to an Educated and Skilled Worker Pool – Every year more than 51,000 degrees are conferred by Greater Philadelphia's colleges and universities, introducing new knowledge and skills into the potential worker pool. Business, liberal arts,

and other broad-based fields of study are the most popular majors of regional graduates at almost all levels of study. Regional economic clusters of professional and data-intensive services benefit from the pool of potential worker candidates who graduate from these programs. The region is particularly strong in awarding first professional degrees (law and medicine). As might be expected with the region's long history of medical leadership, degrees awarded at all levels (except PhDs) for health-related professions are another strength of regional institutions. Our strength in producing health professionals is reflected in a strong regional economic cluster of health care services and products.

Generating Innovation – A core group of universities in the region spent almost $666 million in research and development in 1998 (R&D). Research in Greater Philadelphia is dominated by life and biological sciences. While these fields dominate research funding everywhere, the region has no other science or engineering research strength. This differs from competitor regions, such as engineering in Raleigh-Durham and computer and physical sciences in Silicon Valley. Our research universities have a young but growing capacity to transfer their findings into the commercial world (i.e., tech transfer). In 1998 regional universities struck 141 licensing agreements, the 7th largest number in the country. Many of these agreements were made with start-up and small companies that have high-growth potential.

In the new economy, these contributions are crucial to building and sustaining a thriving, innovative regional economy. Those regions that do a better job of filling the talent pipeline, generating new ideas, and connecting them to their economic fortunes will become magnets for investment, stimulating new company formation, and creating a cycle of activity that brings in young people and keeps talent here.

The Knowledge Industry in Action

In very specific instances, Greater Philadelphia's competitive advantages are directly related to our knowledge industry's core competencies. In a very real sense, the region's strengths in these industries and any resulting economic growth (current and future) are largely due to the core competencies of our colleges and universities in the corresponding fields of study. Three industry clusters in particular have especially strong ties to our knowledge industry's core competencies.

Hospitality and Tourism

For the past decade the Greater Philadelphia region has invested heavily in a multi-dimensional economic development strategy promoting hospitality and tourism in the region. This strategy rests on a solid foundation of existing amenities and assets, particularly a wealth of historical and cultural attractions.

Amidst all the discussion of strengthening hospitality and tourism in the region is an overlooked (or perhaps underpromoted) regional competitive advantage – a set of higher education institutions offering numerous distinguished programs in the visual and performing arts. The strength of these programs attracts students to the region, and their comparatively large enrollment (6th largest in the nation) results in a readily available, steady supply of cultural talent in the region. The physical presence of many of these institutions in close proximity to key tourist attractions makes them an integral part of promoting the region as a tourist destination.

While the full effect of regional investments and efforts in hospitality and tourism have yet to be realized, there is growing evidence that they are beginning to pay off – regional employment in the hospitality industry is growing, high-profile events such as the 2000 Republican National Convention are being brought to town, and industries that are related to the arts are starting to emerge and grow, such as film production and new media.

Professional and Business Services

In a world where first-mover advantage can often determine the difference between market leader and bankruptcy, having skilled professionals – accountants, lawyers, consultants, programmers, advertisers, and others professionals – who are able to advise local startups on growth strategies and more established firms with adaptive strategies is crucial.

Fortunately, Greater Philadelphia's colleges and universities produce a substantial supply of graduates who have acquired professional skills that assist all kinds of businesses in adapting to the new economy. Almost 15,000 or about 30 percent of all graduates in 1996-97 earned degrees in fields of study that support the business world.[2] Our institutions' individual and collective strength in producing graduates equipped with business skills is reflected in (if not a reason for) the high level of professional services employment in the region, which have experienced significant growth in recent years. VerticalNet, a regional company that operates on-line business-to-business (B2B) sites for targeted industries, is a real-world

example of how companies benefit from this regional strength – VerticalNet believes it will be able to fill 1,000 newly created positions with the company – web designers, computer engineers, and customer-support staff with average starting salaries of $55,000 – over the next year by tapping into the pool of talent graduating from regional universities.

Life Sciences

The ties between Greater Philadelphia's knowledge industry and life sciences industries is evident in the strong presence of pharmaceutical companies and health care services (hospitals, physician practices, outpatient care facilities) in the region. The region's colleges and universities directly contribute to the strength of these industries – thousands of graduates from life sciences majors fill positions in these industries, and university research (74 percent of regional R&D expenditures go to the life sciences) fuels the growth of new and existing companies as biology-based innovation is incorporated into the commercial world.

Competing as a Knowledge Region

Despite Greater Philadelphia's historic leadership in higher education, regional comparisons of higher education assets put it clearly in a second tier of leading knowledge regions in the US. Centers of the New Economy such as Boston, the San Francisco Bay Area and Raleigh-Durham are clearly at the top of the class in terms of quantity and quality, while regions like Austin, Pittsburgh and San Diego are aggressively striving to climb higher. All of this says that we need to do a better job of connecting our knowledge industry to our broader economy, and making sure that we are staying competitive in a hyper-competitive climate.

Without continual investment and a more focused regional approach to growing and improving the region's knowledge industry, the risk is that the region could slip further down into the second tier – putting in jeopardy both future economic success and the reputations and caliber of its higher education institutions. The region faces a set of crucial challenges that must be addressed, if it is going to stay in the vanguard of leading knowledge regions:

- Talent attraction
- Reputation
- Innovation
- Critical mass
- Life sciences opportunity

Knowledge Industry Centers in the US

Top Tier: Boston, San Francisco Bay Area, New York, Washington/Baltimore, Raleigh-Durham

Second Tier: Los Angeles, Chicago, Philadelphia, San Diego, Seattle, Detroit

Strivers: Atlanta, Austin, Pittsburgh, Houston, Minneapolis, Denver

Talent: Our knowledge industry is big, but it could be bigger

Despite a full-time equivalent enrollment of over 213,000 students, the Philadelphia region has a ways to go in terms of being competitive with the nation's leading economic regions (and even some of its closest competitors) in terms of the size of its college student base. Currently, Philadelphia ranks seventh in the number of students in its region. Consider these facts:

- Our national share of students lags. If the region drew the same share of students as it has of the US population, we would have 20,000 more FTE students[3] than we currently do.
- From the perspective of pure size, in order for the Philadelphia region to catch the next largest region in terms of student population (Washington-Baltimore), we would need to add at least 51,000 more FTE students. And to catch the region cited most often as an example of the new knowledge regions, the San Francisco Bay Area, we would need to add almost 100,000 new FTE students.
- Finally, if the Philadelphia region drew the same proportion of students as its leading competitors, we would have thousands more students than we do today. For example, if Philadelphia's concentration matched Pittsburgh's, we would have at least 20,000 more FTEs. If we met Denver's concentration, we would have almost 50,000 more FTEs. And to catch Boston's concentration, the region would need over 60,000 more FTEs.

Having a knowledge region befitting our size is not just a matter of competing with other large metropolitan areas, but a key requirement for success in the new economy. Richard Florida, Carnegie Mellon University professor of regional economic development, explains how regions must leverage the talent of universities in the following statement: "Over time, any university or region must be

constantly repopulated with new talent. More so than industrial economies, leading universities and labor markets for knowledge workers are distinguished by high degrees of 'churning.' What matters is the ability to replenish the talent stock. This is particularly true in advanced scientific and technical fields where learned skills (such as engineering degrees) tend to depreciate rather quickly."[4]

The region's undersized student population is already reflected in troubling signs of the pool of educated and skilled workers we offer to regional employers. According to estimates of the region's educated and skilled worker population, only 40 percent of Greater Philadelphia's working-age population (i.e., ages 16 to 64 years) has a college degree or are presently in college, compared with 60 percent in the Raleigh-Durham MSA. These estimates suggest that the regional economy could be reaping greater gains if a larger student population was present for employers to draw upon.

National reputation: Our knowledge industry reputation is good, but not good enough

In an index compiled by PEL, the region ranks 8th for the quality of institutions and academic programs as ranked by *U.S. News and World Report* in 2000. While on the surface this appears to leave the region in good standing, there is a large gap between the top-ranking regions and Greater Philadelphia. The common element of the seven top-ranking regions is the presence of: 1) at least one institution (if not two) that is nationally recognized at the undergraduate level and for all three major areas of graduate study (law, medicine, and business); and, 2) at least one other institution that is nationally recognized at the undergraduate level and for at least one of the three major areas of graduate study.[5]

After this top tier of regions begins another group that is nationally recognized at the graduate and undergraduate level, though this recognition is usually the distinction of only one institution in the region or is the combination of lower rankings of several less prominent institutions. This group includes the Philadelphia region, where the University of Pennsylvania is nationally recognized for overall undergraduate education as well as the three major areas of graduate studies in law, medicine, and business. No other institution in the region shares this distinction. The only other institutions that make a showing in the rankings were placed in the 2nd or 3rd tiers of the *U.S. News* rankings, were high ranking regional universities, or were recognized as high-caliber liberal arts colleges (which have small student bodies).

Total Regional FTE Enrollment

1. New York CMSA (703,800)
2. Los Angeles CMSA (535,700)
3. Chicago CMSA (321,600)
4. San Francisco Bay Area CMSA (309,800)
5. Boston NECMA (268,800)
6. Washington-Baltimore CMSA (264,500)
7. **Philadelphia CMSA (213,400)**
8. Detroit CMSA (173,800)
9. Dallas CMSA (137,700)
10. San Diego CMSA (128,400)

Source: PEL, utilizing National Center for Education Statistics (NCES)

Idea generation: Growing research capacity, but need diversification

The region also lags in research capacity. While nearly $666 million in R&D spending is a significant amount and ranks the region 7th nationally, there is a large gap between Greater Philadelphia and those it trails. It would take over $100 million dollars to catch number 6 (Raleigh-Durham), $490 million to overtake number 5 (Los Angeles), and over half a billion dollars to pass number 4 (Boston). As with the *U.S. News* rankings, the region's research capacity rests largely on the shoulders of the University of Pennsylvania, whose spending accounts for 50 percent of overall regional R&D expenditures. In the leading regions, research activities are often driven by several institutions of similar size and quality (most of which were placed at the top by the *U.S. News* rankings).

What is keeping the academic and research reputation of Greater Philadelphia's knowledge industry from being recognized among the best regions in the country? Regional comparisons of colleges and universities suggest several reasons why this might be the case:

Regional Student Concentration (FTE/1,000 residents)

1. Austin MSA (73)
2. San Diego MSA (46)
3. Boston NECMA (46)
4. San Francisco Bay Area CMSA (46)
5. Denver CMSA (44)
6. Pittsburgh MSA (39)
7. Seattle CSMA (37)
8. Minn/St. Paul MSA (37)
9. Phoenix MSA (37)
10. Chicago CMSA (37)

12. Philadelphia CMSA (35.6)

Source: PEL, utilizing National Center for Education Statistics and US Census data.

Lack of Multiple Nodes of Excellence and Critical Mass – As discussed above, the Philadelphia region has only one institution of highly distinct quality in teaching *and* research, the University of Pennsylvania. In the country's top-ranking regions, there are at least two if not three institutions of Penn's caliber. In many instances these institutions have large student bodies and have affordable in-state tuition rates (e.g., University of California-Berkeley in the San Francisco metro area, University of North Carolina-Chapel Hill in Raleigh-Durham).

Comparatively Homogenous, Yet Fragmented Research Base – The vast majority of our region's research is conducted in the life sciences, particularly the applied world of the medical sciences. Given that four of our top five research institutions are or include academic health centers (Thomas Jefferson University, MCP Hahnemann University, the Hospital of the University of Pennsylvania, and the Health Sciences Center of Temple University) this preponderance of medical science research is not surprising. In fact, the similarity between research institutions suggests that they might be competing intensely for research dollars, rather than looking for areas of collaboration and cross-fertilization between a more diverse set of disciplines.

Weak Engineering Capacity – Comparatively little is being put into engineering-related research in Greater Philadelphia, which is driving much of the innovation in today's new economy. Regions with much stronger engineering-related research capacities – most notably Boston and San Francisco – are likely drawing the best and brightest in terms of students, teachers, and researchers. This trend is born out in the concentration of engineering graduates from these regions – Boston graduates 25 percent more students in engineering and San Francisco graduates 50 percent in engineering than the nation on average, while the Philadelphia engineering graduation rate is 7 percent less than the national average.

Quality Rankings of US Knowledge Regions (PEL Index)

1. New York CMSA (236)
2. Los Angeles CMSA (161)
3. Boston NECMA (152)
4. San Francisco Bay Area CMSA (127)
5. Chicago CMSA (117)
6. Washington-Baltimore CMSA (102)
7. Raleigh-Durham MSA (94)
8. **Philadelphia CMSA (78)**
9. Detroit CMSA (58)
10. Atlanta MSA (44)

Source: PEL, using US News and World Report 2001 rankings of colleges and graduate programs

The challenge for the region is to identify the correct mix of investment and marketing that will build the region's reputation as a center of academic and research excellence.

Critical mass: We need a clearly identifiable center of business and research activity

Most regions that are nationally recognized for their leadership in knowledge industries have developed – either through market forces or as a part of a specific economic development strategy – nationally recognized centers of business and research activity. Whether it is the city of Cambridge in Massachusetts, the Research Triangle Park in Raleigh-Durham, NC, or the Stanford Research Park in Palo Alto, the close relationship between academic and business leadership are readily apparent to both residents of the region and the nation. And the leading regions are not resting. In San Francisco, the proposed Mission Bay mixed use development project has the potential of creating an entirely new community around the biotech research strengths of the University of California-San Francisco. And in Raleigh, North Carolina State University is developing its Centennial Research Campus to serve as an urban alternative to the sprawling Research Triangle Park.

Another new development has been the creation of virtual research centers, centered on a concept or specific field. In Pittsburgh and the State of Georgia, business, government and university leaders, working with the Cadence Corporation, have created prototype consortiums focused on making their regions the leaders in cutting-edge technologies. Pittsburgh's Digital Greenhouse is combining the resources of Carnegie-Mellon University, the University of Pittsburgh and Penn State University with local and national technology firms in an effort to make the region the leader in the development of system-on-a-chip technology, and Georgia's Yammacraw Alliance is undertaking a similar effort. These initiatives can be termed virtual, because unlike other research parks, their focus is not on real

Top Regions for University R&D Spending (millions)

1. New York CMSA ($1,759)
2. Washington-Baltimore CMSA ($1,583)
3. San Francisco Bay Area CMSA ($1,291)
4. Boston NECMA ($1,216)
5. Los Angeles CMSA ($1,156)
6. Raleigh-Durham MSA ($773)
7. **Philadelphia CMSA ($666)**
8. Chicago CMSA ($654)
9. Detroit CMSA ($645)
10. Houston CMSA ($644)

Source: PEL, using NSF data

estate but on ideas and research. By letting the market dictate real estate priorities, these efforts can focus on developing new markets and technologies, rather than filling buildings.

Despite the best efforts of the leadership of the University City Science Center (the nation's first urban research park), the connections between business and academics in Greater Philadelphia have been less successful. However, with the recent efforts of the Science Center to reposition its new and existing real estate products and the ongoing economic development efforts of the University of Pennsylvania, there is an opportunity to identify University City as the research center of the mid-Atlantic region, akin to Cambridge's role as the center of New England's innovation economy. Staking out such a leadership position would benefit the entire region, as the ideas, concepts and companies spun out of University City would help position Greater Philadelphia as a leading region for technology-oriented business. Building a critical mass in University City could also serve as the model for developing similar centers of business and research in the region's other knowledge industry clusters, particularly the North Philadelphia neighborhoods surrounding Temple and La Salle Universities.

Life Sciences leadership: Best bet for Philadelphia's future

Philadelphia's best opportunity for connecting its academic strengths to future economic opportunity are in emerging life sciences industries like biotechnology, bioinformatics, and functional genomics. Much of the region's research strength is in the biological and medical sciences, which account for 74 percent of universities' R&D expenditures. Alongside these research activities is a growing capacity to transfer technology from the university laboratory into the commercial world – Greater Philadelphia institutions were issued the 5th most patents and made the 7th most agreements to license technology to companies in 1998. This university research and tech transfer capacity is a vital ingredient for sustaining and building on the region's life sciences-based industries, which include some of the world's largest pharmaceutical companies (80 percent have a presence in the region) and a growing number of entrepreneurial biotechnology firms.

Given that many experts believe biology-based innovation will soon take over engineering-based innovation as the driving force behind economic growth, the region's prospects for future economic growth could be very exciting. However, the challenge for the region is to act fast and decisively because other states and regions have already committed to and invested heavily in economic development initiatives that aim to capitalize on biotechnology. Some recent examples of initiatives (proposed and underway) are:

North Carolina – North Carolina State University in Raleigh, has built Centennial Park, a mixed used research campus ($340 in development to date) that is intended to rival Research Triangle Park (with potential total build-out to $2 billion). It also has recently launched masters and doctoral degree programs in genomics. UNC-Chapel Hill has committed $100 million to expand its genomics research capabilities. And Duke University is considering spending $200 million on its Institute for Genome Sciences and Policy, a multi-disciplinary research center.

California – Governor Davis of California has proposed appropriating $75 million to create "Institutes for Science and Innovation" at different campuses of the University of California system. These institutes are intended to spur on new industries in close proximity to UC's campuses. UC San Francisco is completing a new medical research center along the city's waterfront that is expected to result in significant economic impact for the city, including the creation of 10,000 to 20,000 indirect private sector jobs in support of the university's research activities.

Michigan – Michigan is undertaking a 20-year, $1 billion initiative to cultivate large clusters of new businesses involved in bioengineering and other emerging life sciences industries. Research conducted at three institutions – Michigan State University, University of Michigan, and Wayne State University – will be the basis for this initiative.

Georgia – The Georgia Research Alliance (GRA), a consortium of the state's research institutions and private sector leaders, is leading the effort to recruit the nation's top scholars in biotech and other science and technology disciplines. In addition, the GRA is coordinating the research-related budget requests of the Alliance members, presenting a united vision and strategy to the state legislature in an effort to build the state's research and development capacity.

The list of proposals goes on and on, as shown in the following box; indeed, most states and many regions appear to be considering economic development goals that involve university research in some manner. Greater Philadelphia's challenge is to bring together the pieces that already exist and build them into something greater.

State and Regional Initiatives Linking Knowledge Industry and Economic Development

- Raleigh-Durham: NC State Centennial Campus ($300M-$2B); North Carolina Biotechnology Center
- San Diego: BIOCom; UC-San Diego Connect
- Detroit/Michigan: Life Sciences Corridor ($1B)
- Pittsburgh: Digital Greenhouse ($13.2 million state investment)
- Baltimore: Johns Hopkins Bay View Research Center
- Boston: Boston university's BioSquare project; Forest City—MIT University Park commercial development in Cambridge
- Illinois: Venture Tech proposal ($1.9 B over 5 years)
- Austin: Microelectronics and Computer Consortium (MCC)
- Atlanta/Georgia: Industries of the Mind Initiative (Atlanta Chamber of Commerce); Georgia Research Alliance; Yammacraw Alliance
- San Francisco Bay Area: Mission Bay development ($1B mixed-use real estate development built around relocation of UC-SF research facilities);Bay Area Sciences Infrastructure Consortium
- Scholarship Programs: California ($1.3 B); Georgia Hope Scholarships; Massachusetts

Where should we be, and how could we get there? Strategies for making Greater Philadelphia one of the nation's leading knowledge regions

If success in the new economy will be increasingly concentrated in those regions with the right combination of smart people and good ideas, it is crucial that Greater Philadelphia be well positioned to capitalize and build upon its existing base of knowledge assets. We are starting from a good place – over the past 250 years, the Philadelphia region has built a knowledge infrastructure that is competitive with any in the world. What we now need to do is honestly evaluate our current standing, and be prepared to invest and seize opportunities in order to position the region as a leader in the 21st Century.

We will not be alone in this pursuit. Other regions and states are acting aggressively and decisively to attract research dollars, recruit eminent scholars, and connect research and talent in their higher education institutions to their local economies. It is clear that the region's knowledge industry must become bigger, better and more well known in order to position the region to capitalize on the new science-based economy. That will require a sophisticated and coordinated mix of planning, investment, and marketing that will result in a knowledge industry base that supports and generates private investment and development throughout the region.

The region stepped up to a similar challenge in the past decade. For years, Philadelphians wondered why we were not getting our share of tourism dollars. Yet when we looked honestly at our assets, we realized that we had been coasting on our historic reputation, rather than striving to be competitive with the leaders in the industry. To some, the Civic Center was perfectly fine as a convention center facility – yet we now realize that the investment in a world-class convention center was necessary for success. When the Pew Charitable Trusts commissioned an analysis of the region's hospitality potential, it quickly become apparent that Philadelphia was slipping far behind other regions when it came to marketing and promoting our wealth of assets. Undertaking such a campaign required new thinking, planning, and significant investment of public, private, and charitable funds. However, it is now clear that the investment in and creation of the Greater Philadelphia Tourism Marketing Corporation was a key factor in the region's recent success. And finally, even as we began to appreciate the potential of our tourism industry, we realized that it would not be enough to live off of our historical assets and success stories. Major investments in the core infrastructure of the industry – hotels, the airport, new tourist attractions like Lights of Liberty, the Constitution Center, and even the Regional Performing Arts Center – were required to keep Philadelphia in the top echelon of tourist destination cities. Yet even after the success of the RNC, it is clear that we cannot rest for even a moment. It is likely that we will need to invest in an expanded convention center, just to keep up with the aggressive investments and actions of our competitors. And we will need to work harder to extend stays of visitors and to fill the rooms of our expanded hotel market.

The knowledge industry is in a similar position. For years, we have drifted along, believing that we were a national leader. Yet it is clear that we are not in the top echelon of knowledge regions with Boston, the San Francisco Bay Area, New York and Raleigh-Durham and we run the risk of being surpassed from

behind by regions like Austin, Atlanta, Seattle, Pittsburgh and San Diego. If we are to be competitive in the knowledge-based economy, the region must be ready to make the investments and commitments necessary to be competitive.

Where should we be headed? The region needs to invest in increasing both the size and quality of its knowledge industry, in order to provide both the workers and the ideas necessary for regional economic success. It must also increase the visibility and reputation of the region's knowledge industry, using sophisticated and targeted marketing campaigns to appeal to a variety of audiences, including potential students, potential researchers, potential investors, and businesses. Following are specific goals and potential strategies that could be employed to meet the challenges faced by the region.

Grow the Talent Base

Greater Philadelphia's knowledge industry is caught in the middle. While the enrollment at regional institutions seems large – over 213,000 FTE students – the region only ranks seventh in terms of total enrollment, despite being the sixth largest region in the country (in terms of population). Of perhaps even greater concern is the concentration of students among the region's population. Highly concentrated regions gain a reputation as "collegetowns" – centers of knowledge and learning where it is relatively easy for employers to identify and recruit the talent necessary to fuel growing companies. It is easy to point to small towns like State College, PA or Madison, WI where a single university dominates the economic landscape and say it will be impossible for Philadelphia to match that concentration. It should be of more concern when major metropolitan regions – places like Boston, the San Francisco Bay Area, San Diego, or Denver – have a much greater concentration of students than Philadelphia. It is no accident that these regions also appear at or near the top of most measures of high-tech activity or entrepreneurial hot spots.

Where does this lead us? If Philadelphia wants to maintain or improve its position as a knowledge region, it must increase both the number of students being educated at regional institutions and the pool of research dollars coming through regional institutions. The first step would be to bring Philadelphia's student concentration to the same ratio as its overall population – that would mean adding 20,000 more FTE students, or the equivalent of graduating 5,000 more students a year. The increase should be strategic, focusing on specifically increasing the number of students being trained in technical fields of engineering and the physical sciences, as well as the basic life sciences where the region lags national concentrations of graduates at various levels. In addition, the gains should be at all levels – associates, bachelors, and masters degrees in all of the disciplines.

What are the benefits of expanding the student pool? Meeting the skills needs of regional technology employers. Potentially reversing the aging of the region by drawing in and keeping more young people. And increasing local and national attention on Philadelphia as a place that welcomes and encourages young people to learn, live, and work.

Potential Strategies

There are a number of ways that the region could add more college students to its population, none of which are mutually exclusive:

- **Market Philadelphia as a center of higher education to graduating high school seniors and potential graduate students, expanding the pool of potential applicants for local institutions.** This should be an opportunity to build upon the Campus Visit efforts begun in 1999 by GPTMC with a well-funded, targeted message to students in the mid-Atlantic region. In addition, international recruitment efforts should be explored, promoting Philadelphia as a city with numerous educational alternatives and options.
- **Strategically expand existing institutions with the room and inclination to grow.** Clearly, not every institution is in a position to expand, but those looking to expand should be encouraged to do so. In recent years, Temple has increased applications and acceptances significantly, as well as increasing the number of students living on campus. Campus expansion programs can be used for community revitalization in those areas where there is room for growth and development.
- **Establish a new technical, research-based state institution.** The quickest way to boost regional enrollment could be through the establishment of a brand-new institution. Around the country, former military facilities and corporate campuses are being converted in public colleges and universities. Perhaps the most prominent start-up has been the conversion of the former Fort Ord army base into the University of California—Monterrey Bay. Vacant properties with existing infrastructure, like those at the Philadelphia Navy Yard, or in some of the empowerment zone areas in

Philadelphia and Camden could be considered as new campuses of state universities or colleges.

- **Develop youth-oriented amenities to attract knowledge workers.** The appeal of the Philadelphia region particularly to young people becomes all the more important as we build and stake our claim as a premier knowledge industry location. We should not assume that traditional notions of amenities are appealing to young people. Rather, becoming known for youth-oriented activities and events – such as the X Games, which the city is presently in the final running for – are a crucial element for expanding the region's talent pool.

Grow the Idea Base

At the same time, the region's research base is a crucial element for future growth in the region as a source of new ideas for existing companies and new companies themselves. The region ranks 7th in research funding, but that research base rests disproportionately on the shoulders of the University of Pennsylvania and is heavily concentrated in the medical sciences. The leading research regions have multiple poles of institutional research strength, as well as stronger bases of research in the basic life sciences, physical sciences, computer sciences and engineering, while remaining strong in medical sciences.

The region should also be concerned about the relatively low ranking of its institutions. Whether one likes the *US News* rankings or not, it is impossible to ignore the fact that the Philadelphia region lags the national leaders in institutional and program rankings. High rankings help to attract students, faculty, and researchers (and research dollars) to the region. They also burnish the region's reputation as a center of knowledge – an important factor in the knowledge economy for attracting people with hot ideas and the money to fuel them.

What are some of the key factors in increasing both the research dollar pool and the quality rankings of institutions? One is recruiting star faculty. A number of regions have set into place strategies to actively recruit and lure star researchers and faculty to their regions to bring their research dollars, reputations, and star students with them. The region's business and civic leadership should set out to recruit a specific number of star researchers to the region – 50 over 10 years – working closely with regional institutions to endow professorships that meet specific regional research and economic development goals. With this, the region should be able to move into the top five of regional rankings for quality of institutions and programs.

Another key factor is cooperation. In a number of regions and states, major research institutions are banding together to increase the pool of research dollars coming into a region. With coordinated approaches, involving both academic and private leadership, the regions are better able to approach government leaders with specific requests for funding, including capital requests. Philadelphia needs to ensure that it maintains its current position, and should set a goal to move into the top five regions for research funding, which would likely require doubling our R&D expenditures. This goal will challenge other institutions (or new institutions) to step up and expand their research programs to provide a counterbalance for the University of Pennsylvania.

Potential Strategies

There are a number of potential strategies for enhancing the region's reputation as a knowledge region and research base**:**

- **Create a research alliance of leading research institutions and private sector leaders.** There is a need for focused attention on the research needs of the region's primary research institutions. By bringing together academic and business leadership, there is an opportunity to strategically address the needs of both the region's business and academic community by working together to recruit and attract top researchers and research funding to the region. In other regions, research and business leaders go together to Washington and their state capitols to lobby for capital and research funding, providing the government leaders with an increased confidence that the needs are part of a strategic plan. The creation of an alliance also provides the ongoing capacity for the region to seek out and attract additional research institutions, whether they be government funded centers (NIH or Defense research labs or centers) or private opportunities (Wellcome Trust, Rand, or other private research facilities).
- **Build a strategic industry-academic consortium in the life sciences to help spur the creation of an industry in the region**. Following the lead of Pittsburgh's Digital Greenhouse, the region should focus on developing the life sciences equivalent, bringing together private and academic interests to push the envelope in identifying specific market niches where the region can be an international

leader. A virtual research center of this type can help to create a buzz about the region, lending credibility to marketing efforts that brand the region as a leading knowledge region.

- **Raise a pool of private funds to support the establishment of endowed chairs at regional research institutions**. The intensity of the competition for star faculty members who can improve institutional rankings and bring in research dollars is intensifying. Other regions are establishing pools of funds to attract the leading biotech and information technology experts to their region. Greater Philadelphia must be prepared to compete with other regions to both attract new brains to campuses and keep our best at home.

Build an Identity and Image for Philadelphia's Knowledge Industry

Despite concerns about size and quality, Philadelphia remains well positioned to assume a role as the research hub of the Mid-Atlantic region. Ideally situated between the international financial capitol of New York and the regulatory and governmental capitol of Washington, DC, the region should be aspiring to assume a knowledge-capitol role similar to that played by Boston in New England. Because both New York and the Washington-Baltimore areas are too big and diverse to be able to claim their areas as knowledge regions, Philadelphia has the opportunity, particularly with a life sciences focus, to claim that mantle. It is a perfect niche for Philadelphia to fill, and it helps to link the region to institutions in New York and Washington, allowing the region to play taller than it currently is while it builds a stronger critical mass of knowledge assets.

If the region is to become the knowledge capital, it also needs a clearly identifiable center of the region's knowledge industry – akin to Cambridge in Boston or the Research Triangle Park in Raleigh-Durham. These are places where knowledge and business intersect and overlap, and where it is clear that knowledge assets are primary factors for the success and growth of industry. Philadelphia's natural corollary to Cambridge is University City. University City is the home to 3 universities, five medical centers, and the University City Science Center. Yet, it has yet to become a hotbed of private activity, despite the best efforts of the Science Center over the years.

However, the opportunity is now ripe to build upon those assets and make University City the focal point of Greater Philadelphia's knowledge industry. The actions of the University City District and the University of Pennsylvania have helped to stabilize and energize the University City community, and there are a number of key opportunities that will be emerging in the coming years that should lead to significant private interest. First, the Amtrak high-speed corridor will open, bringing both New York and Washington-Baltimore closer to University City and 30th Street Station. The Postal Service will be vacating much of its property along the Schuylkill River south of the train station, allowing for potential private development that is linked to the university-hospital research complexes. And, finally the strengthening of Center City as both a business and residential location has created opportunities for new development, which could be focused to the west, effectively linking University City and Center City as a new economy business center. This challenge would require significant leveraging of private sector investment, as seen in other regions, where private sector investment tied to university-related economic development strategies have reached a billion dollars.

Potential Strategies

Potential strategies for branding Philadelphia as a true knowledge region include:

- **Maximize research and development business opportunities in University City.** University City is the natural hub of the region's knowledge industry, and its linkages to Center City should make it a natural center for research-based business activity. Every effort should be made to utilize the Keystone Opportunity Zone incentives and other economic development programs like TIFs to build a critical mass of business and research activity in University City that crosses the river into Center City West. University City has a unique opportunity to combine elements of both Cambridge and the Research Triangle Park in an area immediately adjacent to the region's hub of business activity, with its lawyers, business consultants, accountants, and financiers.
- **Market the region as a knowledge hub.** A comprehensive regional marketing strategy should be developed that realistically highlights the region's strength as a knowledge center, while also focusing on the ongoing efforts to invest and build upon those assets. No longer is it enough to tell a story of what you have or had – it is just as important to tell the story of what you are doing to continuously improve and grow the region's knowledge base.

Why Act Now?

This story is a challenge to the region to think strategically about its future, to build upon a set of

good, but maybe not great, assets, and to dare to think big when it comes to our future. No longer is it enough to be satisfied with being good as a knowledge region. The leading regions are undertaking major initiatives designed to maintain and even surpass their current positions as the nation's leaders. Greater Philadelphia really has no choice if it wants to compete in the new knowledge-based economy. It must recognize that other regions – both ahead of and behind us – are daring to innovate and change their ways of thinking and are already acting aggressively to pursue many of the opportunities laid out here.

The pieces are in place for Philadelphia to capture its rightful place among knowledge regions:

- The state government is actively involved and interested in promoting Pennsylvania and its regions as centers of knowledge and innovation;
- Regional civic organizations and foundations are increasingly focused on capitalizing on the region's knowledge assets;
- We understand that this type of regional transformation can be done – we have learned the lessons from our hospitality industry;
- We understand that we cannot afford to wait – it is clear that the competition isn't.

[1] Defined as the Philadelphia-Wilmington-Atlantic, PA-NJ-MD-DE CMSA: Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties in Pennsylvania; Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, and Salem Counties in New Jersey; New Castle County in DE; and, Cecil County in MD.

[2] Degrees awarded in business management and administration; law; computer information sciences; and, engineering.

[3] Full Time Equivalent enrollment is calculated using the standard formula used in college and university budgeting (full-time enrollment + 1/3 part-time enrollment).

[4] Florida, Richard, "The Role of the University: Leveraging Talent, Not Technology," Issues in Science and Technology (Online), Summer 1999.

[5] For the New York metro area, these institutions are Columbia University, New York University, Princeton University, and Yale University; for Boston, they are Harvard University and MIT; for Los Angeles, they are UCLA and USC; and for Raleigh-Durham, they are UNC-Chapel Hill and Duke University. Most of these regions also have nationally recognized 2nd-tier institutions and liberal arts colleges that round out their reputations as major centers for knowledge workers.

GREATER PHILADELPHIA'S KNOWLEDGE INDUSTRY

Part I: The Role of Colleges and Universities in Regional Economic Growth

Prepared by the Pennsylvania Economy League – Eastern Division

Fall 2000

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On behalf of the project's sponsors, I am pleased to present a collection of reports on *Greater Philadelphia's Knowledge Industry*. Our purpose in undertaking this project was to profile the region's colleges and universities, with the goal of gaining a better understanding of this important regional asset and how it contributes to Greater Philadelphia's economic competitiveness. This goal has led to numerous recommendations for strengthening our knowledge industry, including specific strategies that aim to forge stronger ties between our colleges and universities and the regional economy. The ultimate success of this project, however, will be measured by the report's ability to bring together the region's academic, business, civic, and political communities under a shared vision for our region's future.

In completing this project, we have collected a significant amount of data to profile and benchmark Greater Philadelphia's knowledge industry, allowing for regional comparisons that form an important backdrop describing the global competitive environment. Much of this data was obtained from the National Center for Education Statistics (NCES), which maintains a wealth of data on higher education institutions throughout the country in the Integrated Post-Secondary Education Data System (IPEDS). As you will see, the NCES/IPEDS data set forms the backbone of our research. Many colleges and universities in the Philadelphia region also willingly provided data and insight during the research process, an invaluable complement to the NCES/IPEDS data set. Qualitative insight was gathered from notable sources on higher education, in particular the *Chronicle of Higher Education*, the *Philadelphia Inquirer* and the *Philadelphia Daily News* (for local higher education insight), and various academic publications in the fields of public policy, economics, and higher education administration. Finally, a number of individuals representing the academic, business, and civic sectors in the region previewed the draft research findings, providing important feedback on content and presentation.

Thanks and much deserved recognition go to the following organizations and individuals for their help and assistance throughout the project:

- The Pew Charitable Trusts, through Jim England and Don Kimelman, provided generous initial funding for the project as well as valuable guidance throughout the research phase.
- The University of Pennsylvania, the City of Philadelphia's Commerce Department, and the Pennsylvania Department of Community and Economic Development (DCED) provided generous matching funds for the project as well as valuable guidance throughout the research phase. In particular, John Fry, Jack Shannon, and Anne Taufen of the University of Pennsylvania; Jim Cuorato of the City Commerce Department and former Commerce Director Stephen Mullin; and Tim McNulty of DCED are to be recognized for their contributions.
- More than 60 academic, civic, and business leaders in the region took time to preview the draft research findings, providing valuable feedback on content and presentation.
- The University City Science Center provided initial assistance in organizing the project.
- Lastly, officials of other regions, most notably Baltimore, Boston, Pittsburgh, and the San Francisco Bay Area, graciously hosted the research team during benchmarking visits and provided valuable insight into their regions' knowledge industry initiatives.

The research presented in these reports represents the collective work of PEL Research Associates Annette Goldberg and Ernie Wright, under the guidance of Executive Director David Thornburgh and Deputy Director and Research Director Steve Wray and with the assistance of Research Associate Andrew Maleson and former Research Associate Anuj Gupta. A copy of the report is available on our website: www.peleast.org. We invite your thoughts on this research – please e-mail, call, or write us with your comments.

David B. Thornburgh
Executive Director
Pennsylvania Economy League–Eastern Division

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PROFILE OF GREATER PHILADELPHIA'S KNOWLEDGE INDUSTRY

For an industry as important as Greater Philadelphia's knowledge industry of colleges and universities, it is vital to be able to describe and define the industry itself. Putting Greater Philadelphia's 83 diverse institutions of higher education into a single profile is a daunting task – but in this section we give it our best shot.

Eighty-three colleges and universities form the core of Greater Philadelphia's[1] knowledge industry.[2] In the broadest sense, these institutions of higher education qualify as the knowledge industry by virtue of the knowledge they impart to an enrolled student body (embodied in a degree) and the knowledge they generate through research.[3] While they represent a rich variety of academic disciplines, organizational values, and administrative practices, our colleges and universities face many of the same challenges. They compete fiercely for students and faculty with other regions' colleges and universities and with an increasingly enticing private sector. They are charged with delivering a quality "product," while facing growing pressure to reduce costs, keep tuition under control, and are accountable for their performance. Even the venerable sphere of university-based research is changing as academics are offered stronger incentives and face stiffer competition in the race to commercialize research discoveries. With the emergence of the new economy, where knowledge and ideas are believed to have the greatest value, colleges and universities are increasingly the key to a region's economic development.

Colleges and universities have always played an important economic role in the Philadelphia region. As some of the oldest institutions in the region and even the nation, our colleges and universities have educated generations of regional residents, other Americans, and students from abroad, raising their level of knowledge and skills and preparing them for gainful employment and enterprising ventures. Through their research endeavors, Greater Philadelphia's colleges and universities have spurred on new industries and innovation in existing products and services, creating new opportunities and wealth for the region and the nation.

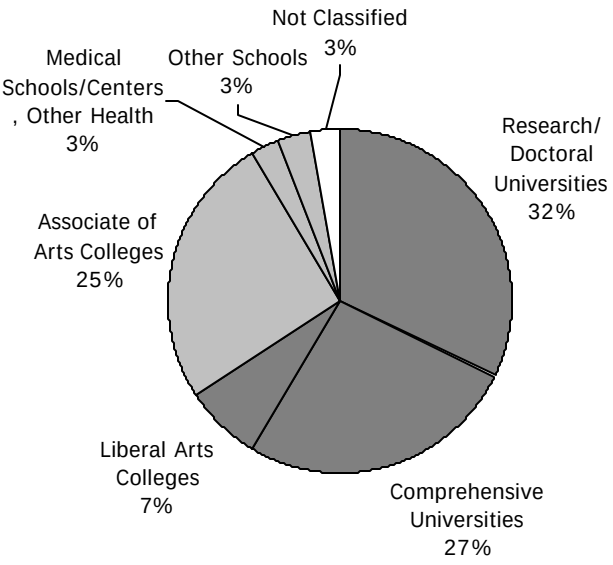
Increasingly, colleges and universities have emerged as major employers in the region. Their purchasing power equals that of major corporations, resulting in the creation of local jobs and businesses. Most important, much of the revenue generated by universities is "new" money to the region – federal research funding and tuition from non-resident students which otherwise would not be entering the local economy. On the qualitative side, colleges and universities provide cultural and recreational opportunities as well as community services such as health care and assistance with K-12 education for residents.

Thus, profiling the region's knowledge industry becomes a key to understanding regional economic competitiveness in the new economy. Understanding the knowledge industry means understanding their institutional, geographic, historical, and economic characteristics.

Types of Knowledge Institutions

Greater Philadelphia's knowledge industry is not a monolith – each institution has its own set of academic goals and achievements. The Carnegie Classification System provides a useful typology for grouping them (Figure 1).[4]

Figure 1. Greater Philadelphia CMSA Student Enrollment (Full-Time Equivalents or FTEs*) by Carnegie Classification



Source: Pennsylvania Economy League (PEL) calculations based on data from the US Department of Education, National Center for Education Statistics (NCES), Integrated Post-Secondary Education Data System (IPEDS), Institution Characteristics, 1997-98 and Enrollment Fall, 1997. *Based on full-time equivalent or FTE enrollment (full-time enrollment + 1/3 part-time enrollment) reported for 81 institutions.

Research and Doctoral Universities

Research and doctoral universities are the region's research leaders, though teaching is also a primary component of their mission. They offer a full range of baccalaureate programs, are committed to higher education through to the doctorate level, and receive significant levels of funding for research, particularly from the federal government. As major research institutions, they often provide technology transfer services as a benefit to faculty researchers as well as other services for promoting business activity, such as incubation or consulting services for start-up companies. While only five institutions in Greater Philadelphia have been classified as research or doctoral universities (Figure 2), they are among the largest institutions in the region and account for almost a third of all student enrollment. Their size, economic prowess, and reputation make them the most prominent institutions in the region's knowledge industry and group them with the most prestigious institutions in the country.

Comprehensive Universities

Like research and doctoral universities, comprehensive universities offer a full range of baccalaureate programs and are committed to higher education at the graduate level. While they might conduct research activities and perhaps even grant doctoral degrees, they do not do so to the extent that research and doctoral universities do. They account for more than a quarter of student enrollment in the region, though there are more of them and they are smaller in size. As major grantors of master's degrees such as MBAs and first professional degrees such as JDs and MDs, they are a primary contributor to the region's professional worker pool and as such enjoy strong recognition within the region and even some recognition outside the region.

Liberal Arts Colleges

Liberal arts colleges are primarily undergraduate colleges with a major emphasis on baccalaureate degree programs. While they might conduct research and perhaps even offer graduate degrees, they do not do so to the same extent as research and comprehensive universities. In some instances, they are very restrictive in their selection process and have earned a national reputation as being highly competitive. They are the smallest of the major classification types, accounting for 7 percent of regional FTE enrollments, and tend to have small student bodies. In spite of their small size, several draw a large portion of their student body from outside the region, raising the overall caliber of the region's reputation and the students who attend regional institutions.

Associate of Arts Colleges

Associate of arts colleges are undergraduate colleges that focus on granting associate's degrees. They include all the region's community colleges as well as a number of proprietary, for-profit institutions. Their programs are often designed as the starting point for students who intend to enter a 4-year baccalaureate program. Their function is teaching undergraduates; with almost no exceptions, they do not conduct research or grant degrees beyond the bachelor's degree level. As the only institution type located in 13 of the 14 counties of the metro area – indeed, in most cases they are partly the creatures of local government – community colleges are the major educators of the region's workforce, particularly entry-level workers and workers with technical skills. With almost a third of student enrollment, they enjoy strong local followings, but little recognition beyond the region.

Medical Schools/Centers and Other Health Professional Schools

These institutions primarily award professional degrees in medicine and other health-related fields such as chiropractic, nursing, pharmacy, or podiatry. They differ from larger universities that have schools of medicine and other health professional programs in that they exclusively focus on professional training and do not offer baccalaureate or graduate programs in fields other than medicine and other health-related professions.

Other Schools

This catchall category includes theological seminaries and Bible colleges, schools of engineering and technology, schools of business and management, schools of art, music, and design, schools of law, and teachers colleges. They are specialized institutions offering a range of degree programs within a single discipline.

Figure 2. Greater Philadelphia's Colleges and Universities by Carnegie Classification and Control Type

	Private, non-profit	State	State-related	County, local	Private, for-profit	Total
Research/Doctoral Universities	3		2			5
Comprehensive Universities	13	4	1			18
Liberal Arts Colleges	9	1				10
Associate of Arts Colleges	5			12	8	25
Med. Schools/Ctrs., Other Health Prof. Schools	5	1				6
Other schools	13		1			14
Not classified		1	2		2	5
Total	48	7	6	12	10	83

Source: PEL calculations based on data from NCES/IPEDS (Institution Characteristics, 1997-98)

Strong Historical Roots

Greater Philadelphia's knowledge industry institutions are deeply rooted in the region's history – with the exception of Associate of Arts Colleges (i.e., community colleges), all the major classifications of institutions have average ages of at least 95 years. The first attempts to establish an institution of higher education were in 1740, but it was not until almost 10 years later under the vision of Benjamin Franklin that the University of Pennsylvania was officially established as the nation's first secular institution. Penn remained the only institution of higher education in the region (that survives today) until 65 years later when the Pennsylvania Academy of Fine Arts, the nation's first art school and museum, was founded. Sixty-eight Philadelphia apothecaries who sought to train apprentices and students in the fundamental sciences underlying pharmacy, biology and chemistry founded the Philadelphia College of Pharmacy, now called the University of the Sciences in Philadelphia, in 1821. By the middle of the 19th century, the region's knowledge industry had grown to 16 colleges and universities, two of which were intended for students of African descent – Cheyney University (1837) and Lincoln University (1854) – a reflection of the region's strong abolitionist stance and philanthropic tradition.

The knowledge industry continued to grow into the next century as the region matured. In 1891 the Drexel Institute of Art, Science and Industry, now known as Drexel University, was explicitly founded to meet the needs of a growing industrialized economy. Leading up to the First World War, colleges of business, nursing, and other trade schools were founded as residents sought to enter the workforce as professionals. The last major wave of institutions

– community colleges and liberal arts institutions – was created in the wake of the Second World War. With more open admission policies, these institutions were created to educate a generation of Americans returning from the war as well as their children, the baby boomers, who are the largest population segment in the country today. The most recently established institutions of higher education tend to be for-profit and proprietary, offering technical skills training and other specialized skills relevant to the modern-day economy.

Today, the knowledge industry remains a visible symbol of societal values regarding opportunity, even as institutions adapt to changes in society's view of what the means to opportunity should be. Unlike most industries, where restructuring often led to company relocation, closures or downsizing, our colleges and universities – "placed-based" institutions by nature – have been comparatively stable entities in our region's communities. At the same time, there has been growing recognition by colleges and universities themselves that active participation and investment in local and regional issues can only stand to improve their institutional well being. The future of the knowledge industry and the region is likely to be one of greater recognition of each other and collaboration between the two.

Prevalence of Private Institutions

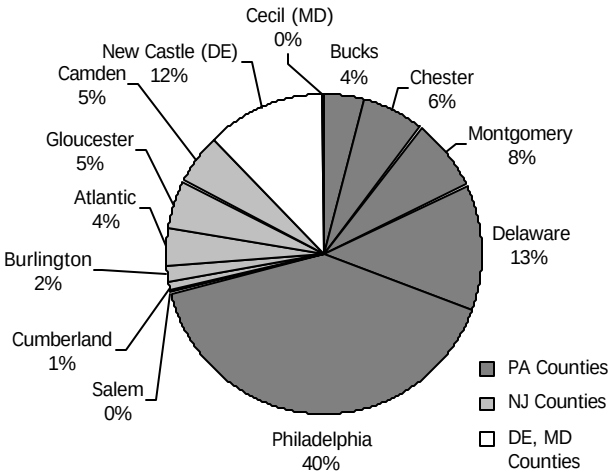
The vast majority of colleges and universities in Greater Philadelphia are private, non-profit institutions. With the exception of community colleges, private, non-profit institutions outnumber other institution types in every category. Indeed, of the region's 83 institutions, only 7 are fully funded by their respective state (5 by New Jersey and 2 by Pennsylvania) and another 12 are affiliated with their host county or local government (and partially funded by their respective state governments). Five regional institutions in Pennsylvania and one in Delaware (the University of Delaware) are considered "state-related" or state-affiliated. These institutions receive some state funding but are privately chartered and -operated schools.

The prevalence of private institutions in the region is likely a reflection of their prevalence throughout Pennsylvania, which has the 3rd most independent colleges and universities in the country (after New York and California). Observers of Pennsylvania's system of higher education have noted that neither of the state's two major cities – Philadelphia or Pittsburgh – has a fully funded state school located within it (though both have state-related institutions, Temple University and the University of Pittsburgh, respectively). On the other hand, none of the 11 institutions in the New Jersey portion of the region is private.

Geographic Clustering and Position

Knowledge industry institutions are located in every county of the region, but their presence is stronger in some, resulting in clustering of institutions and even differences between clusters. The broadest concentration of institutions is in the 5 counties of Pennsylvania, which have 66 of the region's 83 institutions and 71 percent of the enrolled student body (Figure 3).

Figure 3. Distribution of FTE Enrollment by County



Source: PEL calculations based on data from NCES/IPEDS (Enrollment Fall 1997)

City/Suburban Differences

The city of Philadelphia is clearly the regional core of higher education – 40 percent of all students attend institutions in the city, which is home to three of the region's five largest universities.[5] The distribution of students bucks general regional demographic trends – while the overall population of the region has increasingly shifted outward to suburban communities, leaving the city with less than a quarter of the consolidated region's population, the student population still has a strong presence in the city.

Some significant differences arise between the city of Philadelphia and the rest of the region. Four of the region's five research and doctoral institutions, which together have almost three times the number of students as the one suburban research institution (University of Delaware), are located in the city, reinforcing its role as the knowledge industry's core (Figure 4). The suburban counties, on the other hand, have more of an exclusive focus on undergraduate education and professional training through the significant number of liberal arts colleges, comprehensive universities, and community colleges contained within them. Suburban institutions overall also have smaller student bodies on average compared to institutions located in the city.

Figure 4. Philadelphia vs. Rest of CMSA, Difference in Number of Institutions and Total FTE Enrollment

	No. of Institutions		Total Enrollment	
	Phila.	Rest of CMSA	Phila.	Rest of CMSA
Research/Doctoral Universities	4	1	51,020	17,640
Comprehensive Universities	4	14	11,580	44,990
Liberal Arts Colleges	1	9	1,560	14,030
Associate of Arts Colleges	4	21	12,660	41,540
Med. Schools/Ctrs., Other Health	5	1	6,180	N/A*
Other schools	6	8	2,940	3,500
Not classified	2	3	980	4,840
Total	26	57	86,910	126,530

Source: PEL calculations based on data from NCES/IPEDS (Institution Characteristics, 1997-98; Enrollment 1997). Based on enrollment reported for 81 institutions. *Campus-level data not available for the University of Medicine and Dentistry-Camden Campus, Stratford Campus.

Several clusters of institutions are apparent even within the geographic boundaries of the city and the suburban counties. (Refer to *Appendix A: Greater Philadelphia's Colleges and Universities* for the institutions that make up each cluster.) Clustering is an important characteristic of our overall knowledge industry, particularly in the context of the emerging new economy. Institutions that cluster benefit from the interaction of people and cross-fertilization of ideas when both are in a concentrated area. High-tech firms are found in clusters themselves and these clusters are often located close to a university or clusters of institutions. Like colleges and universities, clusters of new economy companies may seek the benefit of "knowledge spillovers" that result from being in close proximity to other knowledge workers. Workers, faculty, and students alike learn from each other's innovation, while employers (including universities themselves) are able to draw from a larger pool of skilled workers.[6] The four major geographic clusters within the region together account for 47 percent of student enrollment (FTE).

University City Cluster

The largest and most visible of these clusters is University City, with one of the highest concentrations of universities, hospitals, and research institutions in the country. Located at the eastern most point of West Philadelphia and directly across the Schuylkill River from Center City, University City draws 14 percent of regional student enrollment and is home to the University of Pennsylvania, Drexel University, and the University of the Sciences in Philadelphia. At one square mile, University City is the most compact of the knowledge industry clusters in the region.

Main Line Cluster

Radiating out from University City and West Philadelphia along Lancaster Pike, Montgomery Avenue, and City Line Avenue is another cluster of institutions in the region's Main Line, a series of suburban affluent communities that sprang up along the regional rail lines. With 10 percent of the region's student population, the Main Line cluster

consists of mostly small liberal arts colleges, including three that are highly selective and nationally-ranked – Bryn Mawr College, Haverford College, and Swarthmore College. It also includes two larger comprehensive institutions – Villanova and Saint Joseph's Universities.

Center City Cluster

Moving east of University City, a cluster of institutions is found within Center City Philadelphia. With 5 percent of the student population, the Center City cluster is a curious mixture of medical sciences and the arts. The Center City cluster contains two of the region's six medical schools and all the region's schools of art and music, such as the nationally-prominent Curtis Institute of Music, the University of the Arts, and Moore College of Art and Design. The location of some of these institutions along Broad Street, also known as the Avenue of the Arts, reinforces their role as the main cultivators of the region's art and cultural talent. The Center City cluster also includes two associate of arts colleges – the Community College of Philadelphia and Peirce College.

North Philadelphia Cluster

The last discernable knowledge industry cluster within the Philadelphia region is located in North Philadelphia. The North Philadelphia cluster has almost as large a student population as University City, though it is spread out over a larger area. The North Philadelphia cluster is anchored by Temple University, which has the largest student body in the region, and includes La Salle University and the Pennsylvania College of Optometry. Many of the students attending these institutions are commuters, making the cluster less cohesive.

Pennsylvania as a Knowledge State

The Commonwealth of Pennsylvania has 228 colleges and universities with FTE enrollment of 464,000 located across the state, with the largest clusters of institutions located in the Philadelphia and Pittsburgh regions (Figure 5).[7] While Philadelphia and Pittsburgh are the largest metro areas in the state, neither has a knowledge industry that is especially larger than what might be expected – both metro areas have student populations that are roughly equivalent to the proportion of students at the national level, as indicated by their student concentration (i.e., FTE enrollment per 1,000 residents). On the other hand, the State College metro area, home to the main campus of the Pennsylvania State University and the third largest student population in the state, has the highest student concentration index by far (287 students per 1,000 residents). Other pockets showing high concentrations of student enrollment occur in the Scranton, Erie, and Williamsport metro areas. Most other metro areas in the state, however, have concentrations of student enrollment below the overall state, and more than 10 percent of student enrollment in the state is not located in an official metro area.

Figure 5. Total FTE Enrollment and Student Concentration for Metropolitan Areas in Pennsylvania

	FTE Enrollment	Student Concentration
Philadelphia, PA 5-county region*	151,900	41
Pittsburgh, PA MSA	91,600	39
Not in metro area	48,400	26
State College, PA MSA	38,100	287
Scranton-Wilkes-Barre-Hazleton, PA MSA	27,600	45
Harrisburg-Lebanon-Carlisle, PA MSA	21,500	35
Allentown-Bethlehem-Easton, PA MSA	20,200	33
Erie, PA MSA	15,400	56
Reading, PA MSA	12,900	36
Lancaster, PA MSA	11,100	24
York, PA MSA	6,800	18
Williamsport, PA MSA	5,800	49
Johnstown, PA MSA	5,500	23
Sharon, PA MSA	3,900	32
Altoona, PA MSA	3,600	27
New York-Newark, NY-NJ-PA (i.e., Pike County)	0	0
PA Total	464,300	39

Source: PEL calculations based on data from NCES/IPEDS, Enrollment, 1997. *The Pennsylvania Counties of Bucks, Chester, Delaware, Montgomery, and Philadelphia.

The East Coast Knowledge Belt

Located in the center of the mid-Atlantic states and the heart of the country's northeastern corridor, the Philadelphia metropolitan region enjoys strong connections between other neighboring metropolitan areas and their colleges and universities. To the north is Princeton University (this year's number one ranking university, according to *US News and World Report*), a prestigious Ivy League research institution located in close proximity to Lower Bucks County, Pennsylvania. To the west of the Pennsylvania suburbs are a number of colleges and universities in Lancaster, Reading, and the Lehigh Valley, such as Millersville University of Pennsylvania, Kutztown University of Pennsylvania, and Lehigh University, respectively. Greater Philadelphia is at the center of an extended knowledge region that stretches along the entire East Coast from Boston to the Baltimore-Washington metropolitan area. The northeastern corridor is home to four of the seven largest knowledge industries in the country (Boston, New York, Philadelphia, and Baltimore-Washington), which account for over 1.45 million in FTE enrollment and $5.2 billion in research and development (R&D) expenditures.

Industry Characteristics

Colleges and universities are major economic players in the region and as an industry their activity is measurably significant. Greater Philadelphia's knowledge industry directly contributes $6.4 billion[8] to regional economic activity through spending on payroll, goods and services, and capital projects. The largest amount of spending is on hospitals, accounting for 26 percent of annual expenditures or $1.65 billion; the Hospital of the University of Pennsylvania alone has more than $1 billion in expenditures.

Tall-Tree Industry

Even when hospital expenditures are excluded, the knowledge industry is dominated by its largest institutions – 20 percent of the institutions account for 78 percent of all spending. More than 50 percent of spending is done by just four institutions – Penn, Temple, University of Delaware, and MCP Hahnemann.[9] Not surprisingly, all four institutions are major recipients of funding for research. The knowledge industry is also a growing one – between 1990 and 1996 it grew at an average annual rate of 3.7 percent, compared to average annual growth of 1 percent for the region as measured by the Gross Regional Product.[10]

An industry dominated by large organizations can work to the overall advantage of the industry. Larger institutions draw attention to the region's knowledge industry as a group, helping to shape the region's industry as a center for learning. Spouses of faculty who are drawn to the region by larger institutions are likely to find employment opportunities at the region's smaller institutions. Likewise, students attending regional schools will find that the range of educational programs offered (from undergraduate to graduate) allows them to chart their entire educational "career" within the Philadelphia region. And corporate recruiters, who already come to the region to visit with students from larger schools, are likely to schedule visits with students at the region's smaller schools as well. The region's arts and culture industry, which is dominated by even larger organizations than those in the knowledge industry, has been described as having this type of symbiotic relationship between large and small organizations with respect to audience development.[11]

Major Regional Employer

Colleges and universities are also a major source of employment for regional residents and are among some of the largest employers in the city and the region. In fact, 42 percent of employment at colleges and universities in Pennsylvania is located in the five counties of Southeastern Pennsylvania.[12] While knowledge industry employment in the Philadelphia area is not as large as that of other major industries such as health services (which includes hospitals), it has a comparably strong presence – university employment as a proportion of total regional employment is 70 percent larger than the nation on average (i.e., employment concentration index or ECI of 1.70). Moreover, the knowledge industry is considerably larger than other industries that receive considerable attention in the media and enjoy strong recognition among residents. For example, employment at hotels (excluding Atlantic City), which have benefited greatly from city economic development investments, is still well below the national employment level (Figure 6). Industry employment growth of 15.6 percent between 1990 and 1997 outpaced overall regional employment growth of 3.2 percent.

Figure 6. Greater Philadelphia CMSA Employment, Payroll, and ECI for Knowledge Industry and Select Industries

Industry (SIC Code)	Employment	Payroll	ECI[13]
Health Services (80)	319,100	$10.7 billion	1.17
Hotels and Other Lodging Places (70)	70,400	$1.7 billion	1.72
Depository Institutions (60)	64,500	$2.3 billion	1.29
Colleges and Universities (822)	**53,100**	**$1.3 billion**	**1.70**
Depository Institutions (60) less Wilmington, DE	41,500	$1.3 billion	0.93
Legal Services (81)	34,200	$1.8 billion	1.46
Hotels and Other Lodging Places (70) less Atlantic City, NJ	18,800	$0.3 billion	0.48
Drugs Manufacturing (283)	9,900	$0.5 billion	1.93

Source: U.S. Census Bureau, County Business Patterns, 1997

Top Exporting Industry

Beyond expenditures and employment, arguably the most significant impact of knowledge industry institutions stems from their tremendous draw of "new" dollars into the regional economy. Hundreds of millions of dollars in research funding, predominantly coming from the federal government, as well as tuition and fees from students who are not from the area flow into the regional economy because of the institutions' existence. A 1990 analysis of regional industries conducted by the Wharton School as part of the Philadelphia Economic Monitoring Project determined that educational services, of which colleges and universities are the main component, were the number one "exporting" industry[14] in the region in terms of industry output.[15] In this analysis the educational services industry topped other industries more commonly believed to be attracting people and dollars to the region, such as tourism (amusement/recreation, ranked 6th) and highly-specialized medical services (part of health care, ranked 10th). While the data underlying the Wharton analysis is dated, the conclusion of the analysis most likely holds true today – colleges and universities are an important in-flow of dollars into the region and therefore a vital component of regional economic growth.

[1] Defined as the Philadelphia-Wilmington-Atlantic, PA-NJ-MD-DE CMSA: Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties in Pennsylvania; Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, and Salem Counties in New Jersey; New Castle County in DE; and, Cecil County in MD.

[2] The figure of 83 institutions was derived from a data set obtained from the U.S. Department of Education's National Center for Education Statistics (NCES), which maintains the Integrated Post-Secondary Education Data System (IPEDS). Refer to Appendix A: Greater Philadelphia's Colleges and Universities for a list of the 83 institutions by Carnegie Classification and Institutional Control and Appendix C: Notes on Methodology for an explanation of the methodology for determining the number of colleges and universities in the Philadelphia region (and comparison regions).

[3] Non-profit research institutions and teaching hospitals, of which the region has several, also could be considered part of the knowledge industry. However, unless noted otherwise, the term "knowledge industry" used throughout this report will refer to the region's colleges and universities.

[4] The Carnegie Classification System was created by the Carnegie Foundation for the Advancement of Teaching in 1994 and is used by the federal Department of Education, NCES to classify institutions of higher education. In this report, the categories are grouped together to simplify the classification of institutions. Refer to Appendix A: Greater Philadelphia's Colleges and Universities for a list of institutions by Carnegie Classification.

[5] In terms of FTE enrollment – Temple University, the University of Pennsylvania, and the Community College of Philadelphia

[6] Schwartz, Amy Ellen and Ingrid Gould Ellen, "Cautionary Notes for Competitive Cities," Wagner School of Public Service, New York University.

[7] NCES/IPEDS, Fall Enrollment, 1997.

[8] NCES/IPEDS, Finances 1995-96. Based on total expenditures of 79 institutions.

[9] MCP Hahnemann is still considered a separate institution in the region, even though Drexel University took over the management of the institution after the bankruptcy of the Allegheny Health Education and Research Foundation and the subsequent purchase by the Tenet Health System.

[10] NCES/IPEDS, Finances 1990-91 (adjusted to reflect real, 1996 dollars) and 1995-96; PEL estimate of Gross Regional Product for the Philadelphia PA-NJ 9-County PMSA. Average annual growth rate based on expenditures at 72 institutions. Refer to Appendix C: Notes on Methodology for an explanation of PEL's estimate of the Gross Regional Project.

[11] PEL (Regional Arts and Cultural Economic Initiative), Greater Philadelphia's Competitive Edge: The Nonprofit Cultural Industry and its Economic Value to the Region, September, 1998.

[12] U.S. Census Bureau, County Business Patterns, 1997.

[13] The Employment Concentration Index (ECI) is the ratio of regional employment in each industry to that in the nation as a whole. An ECI greater than 1.00 demonstrates that the concentration of employment in the given industry is greater than the US average.

[14] Exports, also known as "tradable" goods, are optimal for regional economic growth because their sale draws new money into the region, which is spent and re-spent through the multiplier effect. Non-tradable goods, on the other hand, do not result in any net gain in economic activity because their sale simply re-circulates existing dollars through the regional economy.

[15] Stull, William J. and Janice Fanning Madden (Philadelphia Economic Monitoring Project series), Post-Industrial Philadelphia: Structural Changes in the Metropolitan Economy, University of Pennsylvania Press: Philadelphia, 1990. In this analysis, industries are ranked according to their export share, which is the ratio of net exports (exports minus imports) to the total industry output in the region (sum of local outputs and imports). Figures are derived from the 1986 input-output table for the 9-county Philadelphia, PA-NJ PMSA.

INDUSTRY CONTRIBUTIONS TO REGIONAL ECONOMIC COMPETITIVENESS

Greater Philadelphia's colleges and universities are asked to fill a tall order in our economy – bring in new people, prepare them to be the foot soldiers in the region's economic transformation, and oh, by the way, spin out the ideas that will create our region's version of Dell Computer or Microsoft. Not too big of a job, is it? This section lays out the very real and very important contribution of colleges and universities to Greater Philadelphia's economic competitiveness.

In the context of the new economy, the contributions of colleges and universities to regional economic competitiveness are all the more important because their output is directly tied to economic opportunity and success. In the new economy, traditional business costs – taxes (and tax incentives), land and office space, and energy costs – are becoming less of a factor in location decisions. Rather, businesses are finding that knowledge and ideas are becoming their competitive advantage. People who have knowledge and ideas are assuming the greatest value in the new economy and companies that can recruit and retain them will be successful. Given this fundamental change in the formula for economic success, companies will pay a premium for educated and skilled workers and even locate their businesses where they have access to such a pool of worker candidates and ideas.

The presence of colleges and universities strengthens the region's prospects for success in the new economy. While employment, spending, and community services are important economic contributions of colleges and universities, none of them is directly tied to the fundamental mission of colleges and universities. In the new economy, the fundamental mission of colleges and universities – to generate and impart knowledge – boosts regional economic competitiveness above and beyond their direct economic contributions by:

- Attracting people to the region;
- Creating access to an educated and skilled worker pool;
- Generating innovation; and
- Anchoring communities.

By exploring the collective contributions of colleges and universities, we move closer to understanding the regional economy's ties to the knowledge industry and how these ties affect regional economic performance in the new economy. Only an honest and fair assessment of the industry's contributions to regional economic competitiveness will enable the region to strengthen ties to and capitalize on this vital economic asset.

Attracting People to the Region

Colleges and universities are the region's top exporting industry largely due to the significant amount of research funding and non-resident tuition they draw into the regional economy. But a less recognized though equally important resource they draw in is people – faculty (instructors and researchers) and students. As described by regional economic development professor Rich Florida: "A key and all too frequently neglected role of the university in the knowledge economy is as a collector of talent – a growth pole that attracts eminent scientists and engineers, who attract energetic graduate students, who create spin-off companies, which encourages other companies to locate nearby."[1]

While many of these people are from the Greater Philadelphia area, many come to the region specifically for school or employment and in some cases stay in the region beyond their academic careers. Were it not for the presence of excellent colleges and universities in the region, some native residents, particularly college-bound high school graduates who enroll in local schools, might have left the region for other opportunities. Individual college campuses and clusters of campuses across the region represent critical masses of people and ideas, vital ingredients

for the process of generating innovation. These factors make the knowledge industry a vital entry point for population in-flow and, in the eyes of new economy companies, a regional competitive advantage for accessing an educated and skilled workforce.

The People of the Knowledge Industry

Who are the people associated with the region's knowledge industry? Presently, the region has 27,000 faculty whom are teaching and conducting research on a full- and part-time basis in local colleges and universities.[2] Many of these people come to the region for the opportunity to teach at a regional institution, including 400 academics from foreign countries. The largest groups of people amassed in the region by the knowledge industry, however, are students. Currently, the consolidated Philadelphia metropolitan region has an estimated full-time equivalent (FTE) enrollment of 213,400 students (296,000 full- and part-time students) at its colleges and universities.[3] This student population is the equivalent of 5.6 percent of the region's working-age population (i.e., ages 16 to 64 years). While the vast majority of the region's students are enrolled in undergraduate programs (Figure 7), the region enrolls a higher concentration of students enrolled in advanced studies (graduate and first professional programs) than the nation on average.[4]

Figure 7. Distribution of Student Enrollment (FTEs*) by Level of Study (Philadelphia CMSA vs. US Total)

	Philadelphia CMSA	US Total
Undergraduates	82%	87%
Graduate Students	12%	10%
First Professionals	5%	3%

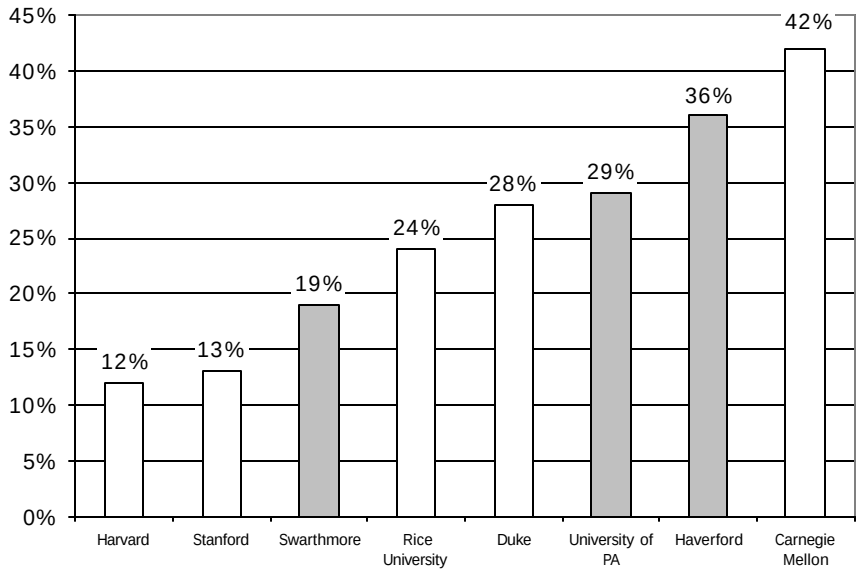
Source: Pennsylvania Economy League (PEL) calculations based on data from the US Department of Education, National Center for Education Statistics (NCES), Integrated Post-Secondary Education Data System (IPEDS), Enrollment Fall1997. * Full-time equivalent (FTE) is the sum of all full-time students + 1/3 part-time students.

Top Talent Attracted to Region

In the fall of 1998 an estimated 73,000 new students – freshmen, transfers, first professionals, and graduate students – enrolled for the first time in Greater Philadelphia's colleges and universities. Of this group, about 25 percent (18,000-19,000) of the student population were not originally from the region, representing an important source of population growth and replenishment.[5] In fact, the yearly gain of new students in 1998 was twice the size of foreign immigration to the region in the same year.[6] The region's graduate programs are a particularly strong draw of students – an estimated 49 percent (7,000) of all graduate and first professional students enrolling for the first time in 1998 were not originally from the region, compared to 19 percent (11,000-12,000) of all undergraduates (i.e., freshmen and transfer students).[7]

Greater Philadelphia's colleges and universities draw some of the country and world's most talented students into the region for school. In the case of the undergraduate population, the highest average SAT scores are found in the colleges and universities that attract the highest share of students from outside the region. According to 1999-2000 data released by the College Board, regional schools that drew at least 60 percent of their freshmen class from outside the region had average 75th percentile SAT scores of 1300 and higher, while schools that drew less than 60 percent of their freshmen class from outside the region had average 75th percentile SAT scores under 1300.[8] A study conducted by the Pennsylvania Independent College and University Research Center confirmed that non-Pennsylvania students enrolled in Pennsylvania schools had higher SAT scores than native Pennsylvanians.[9] In many cases, these schools are not drawing in students who are just smart, but among the brightest of all graduating high school seniors in the country and world. Three institutions (Swarthmore College, the University of Pennsylvania, and Haverford Colleges) rank among the most competitive colleges in the nation with respect to acceptance rates (Figure 8).

Figure 8. Regional Comparison: Acceptance Rate of Select Institutions



Source: The College Board, Common Data Set, 1999-2000. Note: This is not a comprehensive institutional ranking.

Rankings of Undergraduate Teaching and Graduate Studies

The quality of many of Greater Philadelphia's institutions is reflected in national rankings. The most closely followed (and controversial) institution rankings are those published on an annual basis by *U.S. News & World Report* for undergraduate institutions and graduate programs. In the 2001 *U.S. News* rankings, eight institutions from the region made the rankings of nationally recognized institutions and another seven were ranked among prominent schools in the northern region of the country (Figure 9). Most notable of the nationally recognized institutions was the University of Pennsylvania, whose undergraduate schools and three major graduate programs (law, medicine, and business) received top rankings. The region also stood out as having three exemplary liberal arts colleges – Swarthmore College (ranked number two), Haverford College, and Bryn Mawr College. One institution was recognized as a second tier national university – the University of Delaware – and three institutions were recognized as third tier national institutions – Temple University, Drexel University, and MCP Hahnemann University. Villanova University had the distinction of being ranking the number one university in the northern region of the country.

Figure 9. Greater Philadelphia Institutions and Programs Ranked by U.S. News & World Report (Actual Ranking in Parentheses)

UNDERGRADUATE INSTITUTIONS	GRADUATE & FIRST PROF. PROGRAMS
National University, Tier 1 University of Pennsylvania (6) National Liberal Arts College, Tier 1 Swarthmore College (2) Haverford College (6) Bryn Mawr College (16) National University, Tier 2 University of Delaware* National University, Tier 3 Drexel University* MCP Hahnemann University* Temple University* Regional University, Tier 1 Villanova University (1) St. Joseph's University (10) La Salle University (17) Beaver College (19) Rutgers University at Camden (26) Widener University (32) Rowan University (32)	Business (MBA) University of Pennsylvania (3) Law (JD) University of Pennsylvania (12) Medicine (MD) University of Pennsylvania (3)

Source: U.S. News and World Report (website), 2001 Graduate Rankings and College Rankings. *Rankings are not assigned to institutions in Tiers 2 and 3. Note: "Regional" university in this table refers to the states located in the Northern part of the country. A complete list of rankings (overall institutions, graduate programs, and graduate specialties) for Greater Philadelphia institutions is listed in Appendix B: Institution Rankings.

Creating Access to an Educated and Skilled Worker Pool

Attracting people to the region is a key component of population in-flow and stability, especially in the context of slow regional growth and populations losses in the city. However, unlike other industries that attract people into the region, such as tourism and highly specialized medical services, the knowledge industry is unique in that it draws in smart, forward-thinking people who are equipping themselves with knowledge and skills for future employment opportunities.

Perhaps the most important trait that differentiates college graduates, at least in companies' eyes, is that they have learned how to learn. Constant technological advances in the new economy are rendering workers' skills obsolete within a short period of their learning them. Furthermore, as new knowledge is constantly emerging, workers are faced with the challenge of making sense of it. In the new economy, where they only constant is change, workers are expected to take part in not just a system of continuing education, but one of continuous education. Even as companies have taken on more responsibility for worker training, they do regard educational attainment as an indicator of workers' ability to learn.

Where a high school education once earned a worker a secure place in the workforce, now a college education is the preferred employer means to building companies and creating wealth. Economist David Birch regards universities as being "the feedstock of gazelles," his term for the fast-growing companies that are driving product innovation, creating new job opportunities for workers, and fueling regional economic growth. In his observation, high proportions of these fast-growing companies have above average skills needs in their workforce, in essence making a college education a minimum requirement.[10] Given this reality, regions' ability to deliver an educated and skilled workforce will continue to explain much of the difference between them in terms of economic activity.

Degree Concentration

More than 51,000 degrees are conferred each year by colleges and universities in the region[11], introducing new knowledge and skills into the potential regional worker pool. Many of these graduates are new workers entering the

labor pool, while others are existing workers who attended school to upgrade skills or redirect their career path. At the undergraduate level, although the region's proportion of bachelor's degrees approaches the national average, it lags significantly (22 percent below the national average) in the number of associates degrees produced. While the majority of degrees are awarded to undergraduates, the proportion of students graduating from graduate programs is 31 percent larger than the nation's proportion, as indicated by the graduate concentration index or GCI[12] (Figure 10).

Figure 10. Degrees Conferred by Greater Philadelphia Colleges and Universities: Undergraduate vs. Graduate Degrees

	No. Degrees Conferred	Percent of Total	GCI
Associate's	9,870	19%	0.78
Bachelor's	25,360	50%	0.97
Undergraduate degrees	35,230	69%	0.90
Master's	11,250	22%	1.21
Doctorates	1,230	2%	1.21
First Professionals	3,360	7%	1.92
Graduate degrees	15,840	31%	1.31
TOTAL	51,070		

Source: PEL calculations based on data from NCES/IPEDS, Completions 1996-97

The rate of first professional degrees conferred was even higher (92 percent larger than the national average). The first professional student population is spread out among four law schools, six medical schools (two of osteopathy), two dental schools, two pharmacy schools, one school of veterinary medicine, one optometry school, and five theological seminaries. The share of master's and doctoral degrees awarded is 21 percent larger than the national average. Of this group, fourteen universities award Master's Business Administration (MBAs), including one of the nation's top business schools – the University of Pennsylvania's Wharton School.

Regional Strengths and Weaknesses

Business and Liberal Arts

While together the region's colleges and universities confer degrees in every conceivable academic program, what the region appears to produce most of are workers with business skills, liberal arts, and other broad-based backgrounds, with the notable exception of degrees at all levels (except doctoral) awarded for health-related professions (see *Appendix A* for the number of degrees conferred in and the concentration of the region's top-producing majors). Business management, general studies, education, and other fields of study in the liberal arts and humanities are top producers of graduates in almost all degree types.

The strong showing of degrees conferred in business, liberal arts, and other broad-based majors is not uncommon. These majors are the most popular at colleges and universities throughout the country – in most instances, degrees in these fields as a proportion of all degrees conferred in the region are equal to or lower than what is produced at the national level, according to the GCI.

While more attention is being paid to the absolute shortage of workers with technical skills, the need for workers with communication and analytical skills is also high and this need can be filled with workers from liberal arts and other broad-based programs. Furthermore, their strong showing is likely a reflection of the region's economic strengths. Above-average economic activity has been identified in the professional services cluster and the data-intensive services cluster, as reported by Greater Philadelphia First (GPF) in its annual regional benchmarking report.[13] Graduates from the region's colleges and universities are ideal worker candidates for these regional employers.

Life Sciences

While the most commonly conferred degrees in Greater Philadelphia are in business, liberal arts, and other broad-based fields, the notable exception are degrees awarded in health related professions and related sciences. Degrees conferred in this field of study are among the top three producing fields for all levels of study except doctoral degrees. In particular, Greater Philadelphia produces the third most graduates from first professional programs in health related fields in the country – advanced degrees in medicine, pharmacy, osteopathy, and other health-related fields. The region's exceptional capacity to train doctors is reflected in the fact that an estimated one-fourth of all physicians in the United States have undergone some part of their education or training in the Greater Philadelphia

region.[14] It also is reflected in the above-average level of economic activity reported by GPF for the health care products and services cluster.

Engineering, Mathematics, Computer and Physical Sciences

Noticeably absent from the top producing programs in the region are graduates in science and engineering (S&E) fields, such as computer information sciences, engineering, and the physical sciences. This is not entirely surprising given that these majors tend not to be the top producing in any region. However, other regions appear to produce greater concentrations of S&E majors than what is found in Greater Philadelphia and the nation as a whole (Figure 11). Only in the health-related sciences does the region produce a significantly larger share of degrees than what is produced at the national level. In all other fields of science and engineering, the region produces roughly at or below what is produced at the national level, as indicated by the GCI. All other regions compared to Greater Philadelphia below have greater concentrations of graduates in at least one S&E field in addition to (or instead of) health-related professions.

Figure 11. Regional Comparison: Degrees Conferred and Graduate Concentration Index (GCI) for Select Science & Engineering Fields of Study

	Philadelphia CMSA		Boston NECMA		Houston CMSA	
	Degrees Conferred	GCI	Degrees Conferred	GCI	Degrees Conferred	GCI
Comp. Info. Sci.	1,110	1.06	1,430	0.97	360	0.88
Engineering	1,970	0.93	3,780	1.25	870	1.02
Bio/Life Sciences	1,690	0.97	2,410	0.98	800	1.16
Mathematics	350	0.86	680	1.16	220	1.35
Phy. Sciences	630	0.90	1,160	1.18	250	0.89
Health Prof.	7,770	1.36	9,260	1.15	3,530	1.56
	Pittsburgh MSA		Raleigh-Durham MSA		San Fran. Bay Area CMSA	
Comp. Info. Sci.	660	1.34	280	0.76	1,320	1.08
Engineering	1,030	1.04	1,680	2.22	3,740	1.50
Bio/Life Sciences	550	0.67	1,350	2.19	2,460	1.21
Mathematics	210	1.10	320	2.18	460	0.95
Phy. Sciences	300	0.91	570	2.31	910	1.12
Health Prof.	3,520	1.32	1,950	0.96	4,450	0.66

Source: PEL calculations based on data from NCES/IPES, Completions 1996-97

Generating Innovation

If educated and skilled workers are the fuel that drives the growth of new economy companies, then innovation in the form of knowledge and ideas are their engine. Traditionally, university-based research has always been a source of formal, explicit knowledge in the sense that researchers are free from the reigns of commercialization and profit-interest in their academic pursuits. Subsidized in great part by federal dollars and internal funding, university-based research might be so cutting-edge that its application and practical value, if any are to be found, are not yet clear to the commercial world. Indeed, university-based research has been the seed for entirely new industries, such as biotechnology. Some believe that the US' dominance in biotechnology is largely attributable to the strong ties between universities and industry.[15]

In addition to knowledge in the traditional sense, universities also are a source of innovation with clearer commercial application – product or process improvements for existing industries that make smart business sense. Academics have been instrumental in promoting this type of innovation through research activities, direct consulting services, or on the lecture circuit. Technological advances have allowed them to make more direct contributions through software development and other forms of information technology. With the strong backing of venture capitalists and in some cases the public markets, academics have even ventured into the for-profit world themselves. The *Chronicle of Higher Education* reports that at least a few dozen professors of computer science and other related high-tech fields have become multi-millionaires through their involvement in internet-related companies, and

Stanford's Computer Science Department Chair believes that one-third of the department's professors are millionaires.[16]

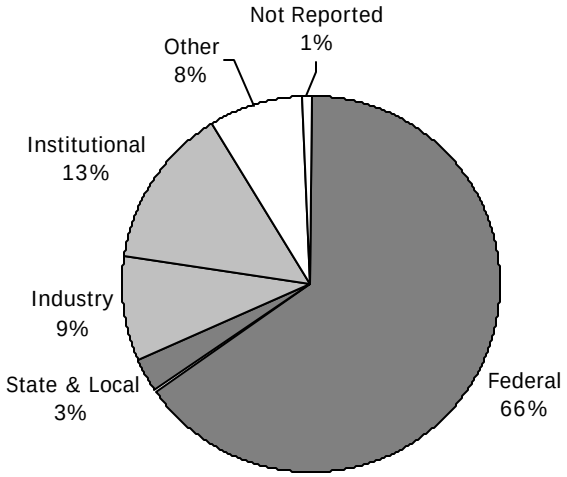
In both cases, the process of generating innovation has become very efficient and "rational" due to tremendous technological advances. For example, in the field of drug research, the development of massive computer databases of chemicals and compounds has led to high through-put screening processes that are drastically reducing research costs, especially compared to the traditional trail-by-error approach. Another example is the Human Genome Project, an international collaboration to sequence and store the genetic code of some 100,000 human genes. The human genome, now completely mapped, forms the foundation of the new fields of functional genomics and bioinformatics, which are expected to fundamentally alter the process of detecting and curing diseases, prescribing drugs and other medical treatments, and developing drugs. Technological advances such as these have freed up the traditional research process such that "…in today's information age ideas have become prized commodities."[17]

What is the role of university research in the emerging new economy? Increasingly, larger companies are shifting resources away from internal R&D activities and focusing more on their core competencies – product development, improvement and approval, marketing, and distribution. As a result, their R&D activities are being shifted toward collaboration with small, entrepreneurial R&D firms, a trend the *New York Times* refers to as "external innovation."[18] At the same time, universities have become very efficient at conducting research and laying the groundwork for commercialization, helping to bridge the gap between discovery and proof-of-concept. Increasingly, university research and even university researchers (including graduate research assistants) are the catalyst for small R&D startups that act as external innovators for larger commercial interests. David Birch, an economist highly regarded for his research on entrepreneurship and the high-tech economy, includes university research as another "soft determinant" of entrepreneurial activity, asking the following question: "Does the local university encourage its faculty and its students to participate in entrepreneurial spin-offs, and do they?"[19] Under this model of university-industry collaboration, which is particularly apparent in biology-based fields, university research becomes an integral component of economic growth.

Core Group Engaged in Research

Greater Philadelphia's knowledge industry stands out as a significant player among competitor regions in university-based research. According to the National Science Foundation (NSF), the region's institutions spent a total of $666 million in research and development (R&D) in 1998, 66 percent of which was funded by the federal government (Figure 12).[20] A core group of 17 universities is engaged in research.[21] Forty-two regional Ph.D. programs were placed in the top 25 of their field or research specialty by the 2001 *U.S. News & World Report* rankings.[22]

Figure 12. Greater Philadelphia R&D Expenditures by Source of Funding



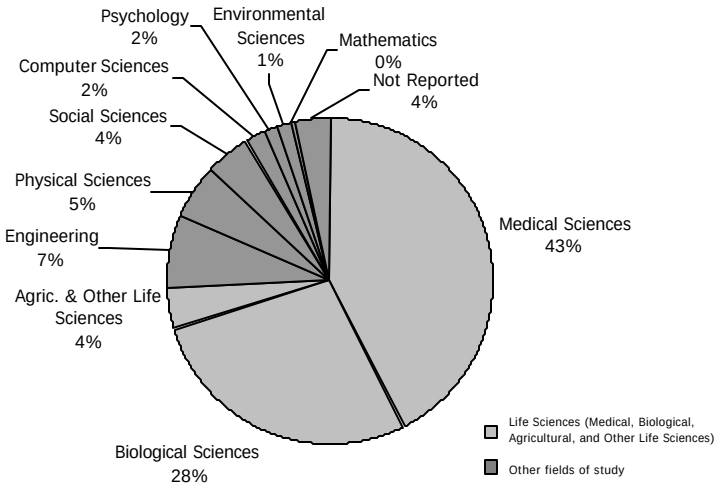
Source: PEL calculations based on data from the National Science Foundation (NSF), 1998

As with rankings in teaching, the University of Pennsylvania stands out as the "tallest tree" among the Philadelphia region's core group. Penn's research programs received 50 percent of all university R&D expenditures in 1998; its graduate programs awarded 36 percent of all doctoral degrees conferred in the region; and it claims 40 of the 42 top ranked regional Ph.D. programs. Penn is the 2nd largest national recipient of grants from the National Institutes of Health[23] and the funding stream thus far for fiscal year 2000 puts Penn on a course for becoming the top recipient of NIH grants. In a recent speech to the Greater Philadelphia Chamber of Commerce, University President Judith Rodin gave an inventory of Penn's immense research capacity – $333 million in R&D funding, 1,000 principal investigators, 2,300 research projects, and the largest university research complex in the mid-Atlantic region.

The region's research capacity is bolstered by the activities of other institutions as well. In addition to Penn, four other institutions in the region had R&D expenditures of at least $50 million.[24] Thomas Jefferson University in particular is emerging as strong force with almost $70 million in R&D expenditures, the fourth most in the region. Jefferson is planning to expand its research capacity by some 70-75 new positions once construction of a new $59 million cancer research center, to be located on its Center City campus, is completed. The University of Delaware is the region's strongest research institution in the field of engineering, accounting for almost 50 percent of regional expenditures in this field in 1998.

Our region's research strength is in the life (medical and biological) sciences, which accounts for about 74 percent of R&D expenditures by regional institutions; no other field of study draws in more than 7 percent of R&D funding, as reported by the NSF (Figure 13).

Figure 13. R&D Expenditures by Greater Philadelphia Institutions by Field of Study



Source: PEL calculations based on data from NSF, 1998

Growing Tech Transfer Capacity

As the region's research capacity has grown in terms of expenditures, so too has universities' ability and commitment to commercialize their research findings. Technology transfer is the term used to refer to patenting and licensing services provided by universities to faculty researchers. In 1980, Congress passed the Patent and Trademark Act (also known as the Bayh-Dole Act), which gave universities the right to take title to any discoveries resulting from research funded by the federal government. Since the passage of this law, most universities with significant research capacities – doctorate-granting institutions specializing in engineering and/or health-related fields – have built the capacity to deliver technology transfer services to faculty researchers.

Nine research institutions in the region have offices of technology transfer – 6 universities and 3 non-profit research institutes.[25] As with overall R&D expenditures, the dominant player in the technology transfer world is the University of Pennsylvania, which accounted for 44 percent of the full-time equivalents and 58 percent of licensing

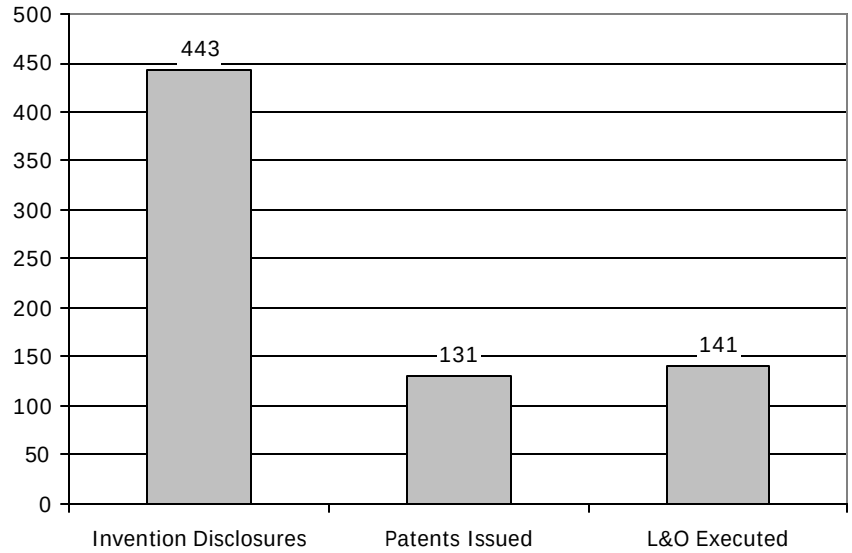
income received during the 1998 fiscal year. According to Lou Berneman, Managing Director of the Center for Technology Transfer at the University of Pennsylvania and former President of the Association for University Technology Managers (AUTM), universities engage in technology transfer for the following reasons:

- to serve the public good (as directed by the Bayh-Dole Act);
- to award and retain faculty;
- to create research opportunities and secure funding for faculty;
- to generate income; and,
- to generate economic growth.

Technology transfer activities plant the seeds for future economic growth. According to a statistical analysis of Penn's technology transfer activities, each license yields an average annual induced investment of $1 million in the pre-commercialization stage (i.e., R&D expenditures made by the licensing company to continue study of the university-based research finding). Licenses associated with biotechnology start-ups have average annual inducement investments of $2.75 million. Once a licensed technology is commercialized, the economic activity generated by the license is essentially the sales and revenue generated by the license (i.e., royalties, equity income) for the university and researcher.[26] Research activities associated with induced investments create job opportunities that would not have been created were it not for the original university research activities.

In fiscal year 1998, 141 licensing agreements were completed by non-profit research institutions in the region (Figure 14). Much of this licensing activity was with smaller, entrepreneurial firms who are laying the seeds for future economic growth – of the 141 agreements, 9 percent were with start-up firms and 54 percent were with small companies. Regional research institutions were directly involved in the formation of 10 of the 12 start-up companies to which technology was licensed, demonstrating their growing capacity and commitment to commercialize cutting-edge technology that still may be years away from market introduction.

Figure 14. Technology Transfer Activities (Invention Disclosures, Patents Issued, Licenses and Options Executed) for Greater Philadelphia Institutions, FY1998



Source: PEL calculations based on data from the Association for University Technology Managers (AUTM), FY1998 Licensing Survey.

Licensing agreements, however, are not always made with companies located in the region. Universities do not necessarily see the commercialization of their research findings as being a regional economic development vehicle – from their point of view, discoveries are to be licensed to the best fit for the patent (and the public good, as directed by federal law), regardless of where the licensing company is located. According to AUTM, which issues yearly statistics on technology transfer activities of universities and other non-profit research institutions, an average of 74

percent of all licensing agreements originating from university research were made with local companies, many located close by the licensing institution.[27] One local technology transfer official believes this percentage might be lower in the Philadelphia region.

Nevertheless, the AUTM statistics show that the region's technology transfer activities are strengthening – almost a third of all currently active licenses and options were executed in the most recent fiscal year. Furthermore, many of these agreements have yet to bear fruit, given that the technology transfer process can be long and expensive – according to Lou Berneman, each invention can take as long as 2 to 5 years at a cost of $20,000 to $100,000 to be patented and licensed. Life sciences research tends to be more cutting-edge and therefore activities leading up to proof-of-concept take place over an even longer period of time. Initial financing costs for biology-based start-ups are comparatively high – start-ups in engineering-based companies can be as low as $250,000 while biomedical start-ups have minimum seed financing requirements of $10 million.

Anchoring Communities

Since their founding, colleges and universities have played an important role as community centers. As large, place-based employers that provide communities with park-like grounds, recreational and cultural facilities, and student bodies that patronize local businesses and restaurants, it is no surprise that colleges and universities often serves as the centerpieces of our most attractive communities. As described earlier, the region's clusters of universities – in University City, North Philadelphia, Center City, and along the Main Line – contribute energy, vitality, and stability to those communities. The colleges and universities often provide additional security for their neighborhoods, promote events that bring together the local community, staff, and students, and are even investing directly in neighborhood development, in order to improve the quality of life in their home communities.

Increasingly, businesses are seeing the benefits of proximity to campuses as an important competitive advantage, just as residential communities have often benefited from the amenities and services provided by the college communities. However, it is not just for the amenities that colleges provide that businesses value proximity to college and university campuses. Now, businesses believe that proximity can be an important business benefit due to the ability to access an available labor force (both in-school and recently graduated) and a marketplace of ideas and knowledge.

Philadelphia was one of the first to attempt to tap the economic benefits of proximity to colleges and universities when it established the nation's first urban research park, the University City Science Center, adjacent to the Penn and Drexel campuses in West Philadelphia. While the success stories of its nearly forty year history have been well-documented, in recent years the Science Center has refocused its energies on capitalizing on the synergies between knowledge based industries like information technology and biotechnology and the research and labor pools available on local campuses. Combined with Penn's efforts to improve the quality and safety of residential neighborhoods and broaden the local retail community as well as major parcels of land available for new development on the fringes of University City, there is an opportunity for University City to emerge as a major knowledge-based business and residential district.

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[1] Florida, Richard, "The Role of the University: Leveraging Talent, Not Technology," Issues in Science and Technology (Online), Summer 1999.

[2] U.S. Department of Education, National Center for Education Statistics/Integrated Post-Secondary Education Data System (NCES/IPEDS), Fall Staff 1997.

[3] NCES/IPES, Enrollment Fall 1997. Based on enrollment reported for 81 institutions.

[4] Undergraduate students are students enrolled in Associate's or Bachelor's degree programs. First professional students are students enrolled in a professional graduate program, which are the following specialties: chiropractic, dentistry, medicine, optometry, osteopathic medicine, pharmacy, podiatry, veterinary medicine, law, and theology. Graduate students are students enrolled in all other Master's degree and Doctorate programs not listed under the first professional category, including Masters of Business Administration (MBAs).

[5] PEL estimates. Refer to the Appendix C: Notes on Methodology for an explanation of the methodology and underlying assumptions.

[6] US Immigration and Naturalization Service, which reported in the 1998 Statistical Yearbook that 9,917 foreign immigrants came to the 9-County PA-NJ Primary Metropolitan Statistical Area in 1998. While this figure does not include the remaining counties, it is likely to be very close to the actual figure for the 14-County PA-NJ-DE-MD Consolidated MSA.

[7] About 2 percent of the region's student enrollment (undergraduate, graduate, and first professional; non-FTE) is made up of foreign students.

[8] The College Board, Common Data Set (Undergraduates), 2000. Based on 75th percentile scores submitted by 25 institutions (for which data on students' origin was available).

[9] The Pennsylvania Independent College and University Research Center. Patterns of Success After College: Labor Market Conditions and Outcomes for Recent Baccalaureate Recipients from Independent Colleges and Universities in Pennsylvania. 1996.
[10] Cognetics, Corporate Demographics: Entrepreneurial Hotspots (The Best Places in America to Start and Grow a Company), 1999.
[11] NCES/IPEDS, Completions 1996-97. Based on completions figures reported for 81 institutions.
[12] Like the employment concentration index (ECI), the graduate concentration index (GCI) is the ratio of degrees conferred in each field of study as a proportion of all degrees conferred in the region to the nation's proportion. A GCI greater than 1.00 demonstrates that the concentration of degrees conferred in the given field of study in the region is greater than the US average.
[13] Greater Philadelphia First (GPF), Regional Economic Benchmarking Report, 1999. Greater Philadelphia is defined by the 9-county Philadelphia PA-NJ PMSA in this report. See Appendix C: Notes on Methodology for explanation of industry sectors that make up each regional economic cluster.
[14] Pennsylvania Economy League (PEL), Greater Philadelphia's Challenge: Capitalizing on Change in the Regional Health Care Economy. February, 1996.
[15] Press, Eyal and Jennifer Washburn, "The Kept University," The Atlantic Monthly, February 17, 2000, pp. 39-54. Walter Powell, a sociologist at the University of Arizona, made this claim in the article.
[16] Wilson, Robin, "They may not wear Armani to class, but some professors are filthy rich," The Chronicle of Higher Education, March 3, 2000, pp. A16-18.
[17] Press and Washburn, 2000.
[18] Gerth, Jeff and Sheryl Gay Stolberg, "Drug Companies Profit from Research Supported by Taxpayers," The New York Times, April 23, 2000.
[19] Cognetics, 1999.
[20] National Science Foundation (NSF), Academic Research and Development Expenditures, Fiscal Year 1998 (early release tables). An estimated $100 million in R&D is spent by non-profit research institutions and teaching hospital in addition to universities' $599 million in R&D expenditures, as reported by the Association of University Technology Managers' (AUTM) FY98 Licensing Survey.
[21] As indicated by R&D expenditures released by the NSF. AUTM reports that two non-profit research institutions (the Wistar Institute and the Fox Chase Cancer Center) and one hospital (Children's Hospital of Pennsylvania) have significant R&D expenditures as well.
[22] Institutions received top-25 rankings for overall programs and specialties in: engineering, education, biological sciences, chemistry, computer science, economics, English, history, math, physics, political science, psychology, and sociology. Refer to Appendix B: Institution Rankings for a complete list of U.S. News & World Report rankings for Greater Philadelphia institutions and graduate programs.
[23] After Johns Hopkins University in Baltimore, MD.
[24] MCP Hahnemann University ($96 million), University of Delaware ($70 million), Thomas Jefferson University ($70 million), and Temple University ($63 million), as reported by the National Science Foundation in 1998.
[25] As reported in the AUTM FY98 Licensing Survey. The three research institutes with tech transfer offices are: Children's Hospital of Philadelphia, Fox Chase Cancer Center, and the Wistar Institute. Drexel University, which has a tech transfer office but does not report to AUTM, has been included in the regional count.
[26] Kramer, Peter B., et.al. "Induced Investments and Jobs Produced by Exclusive Patent Licenses – A Confirmation Study," 1997, pp. 79-100.
[27] AUTM, FY1998 Licensing Survey.

THE KNOWLEDGE INDUSTRY IN ACTION

Philadelphia's Knowledge Industry has played a leading role in the development of companies and sectors of our economy over the past 200 years. In particular, the strengths of the region's programs in the performing and visual arts, business, and life sciences have been key to the development of regional strengths in hospitality and tourism, business and professional services, and the life sciences. In this section, we take a look at how the region's strengths have been translated into economic growth centers.

Greater Philadelphia's colleges and universities make important contributions to the regional economy – for example, by raising the overall level of educational attainment of residents and improving their earnings potential. In very specific instances, however, regional competitive advantages are directly related to our knowledge industry's core competencies. Three industry clusters in particular have especially strong ties to our knowledge industry's core competencies:

- Hospitality and tourism, which benefit from the knowledge industry's draw of people into the region and the cultivation of cultural talent;
- Professional services, which benefit from the pool of workers with business skills graduating from regional universities; and,
- Life sciences industries, which absorb innovation generated by university research as well as science researchers and health care professionals emerging from university laboratories and classrooms.

In a very real sense, Greater Philadelphia's strengths in these industries and any resulting economic growth (current and future) are largely due to the core competencies of our colleges and universities in the corresponding fields of study.

Hospitality and Tourism

For the past decade the Greater Philadelphia region has invested heavily in a multi-dimensional economic development strategy promoting hospitality and tourism in the region. This strategy rests on a solid foundation of existing amenities and assets, particularly a wealth of historical and cultural attractions. A 1995 report commissioned by the Pew Charitable Trusts stresses the importance of building on these assets in promoting hospitality and tourism: "…Philadelphia, like many urban centers in the US, possesses a wide variety of tourist attractions. It's forte, however, [is] cultural and heritage tourism…"[1]

According to the Pennsylvania Economy League (PEL), the regional arts and culture sector consists of some 350 not-for-profit arts and culture organizations, encompassing the performing arts, museums, galleries, historic and scientific museums, historic societies, art centers, literary magazines, arts councils, and art-oriented community service organizations. The vast majority of these organizations, including the largest organizations, are located in the city – according to an organizational survey conducted by PEL, city organizations accounted for 81 percent of total nonprofit cultural spending.[2] Within the city itself is a concentration of institutions in Center City, including Independence National Historical Park (home of the Liberty Bell and Independence Hall) and the historical district of Old City, which alone draw close to one million tourists to the city each year.

Strategic Investments in Product Improvement and Marketing

With the goal of drawing even more cultural tourists into the region, strategic investments are being made in new infrastructure that complements the existing base of assets. The most ambitious efforts in recent years have targeted a cluster of cultural institutions located along Broad Street north and south of City Hall, now known as the Avenue of the Arts. More than $650 million in investment has been made or committed to the cultural and educational infrastructure of the Avenue of the Arts. The densest concentration of institutions along the Avenue is a one-mile

stretch of South Broad Street between City Hall and Washington Avenue, home to eleven cultural and educational institutions and seven performance venues. When the $250-million Regional Performing Arts Center is complete, the Avenue of the Arts will have more than 10,000 seats for performances.[3] Other initiatives seek to maintain and improve upon the organizational capacity of arts and culture in the region, such as the Greater Philadelphia Cultural Alliance, which is in the process of preparing a regional cultural plan to shore up the resources of member cultural institutions.

As the "cultural product" offered by the region has improved, so too has the capacity to handle greater volumes of tourists and travelers. With the opening of the Pennsylvania Convention Center and the construction of several new hotels in Center City, the region is now able to compete for larger gatherings of business travelers (such as the Republic National Committee, which chose Philadelphia as the site of its 2000 convention), with the goal of attracting these travelers back with their families for leisure vacations. On the workforce side, entities such as Opportunities Inn, an initiative of the Philadelphia Opportunities Industrialization Center and the Pennsylvania Convention Authority, are training workers to fill new jobs created in the hospitality industry, including individuals who previously might have lacked marketable skills.

The keystone of the economic development strategy is an intense, high-level marketing campaign promoting the region as a tourist destination. The Greater Philadelphia Tourism and Marketing Corporation (GPTMC) was created to run this marketing campaign, with the Philadelphia Convention and Visitors Bureau (PCVB) handling the resulting increase in sales volume. More than just a promotional campaign, GPTMC's strategy is to identify potential tourists for whom the region holds high appeal and then package and pitch experiences to them in order to draw them to the region. For example, GPTMC recently launched Campus Visit, a marketing campaign that targets families whose children are applying for college. Campus Visit pitches the region as "one big campus," hitting home the fact that families not only can visit any number of the 50 schools that are listed in the promotional materials, but also can take part in the extensive cultural experiences the region has to offer in one trip (hopefully over the course of several days and nights).

Knowledge Industry Contribution: Cultivating Cultural Talent

Amidst all the discussion of strengthening hospitality and tourism in the region is an overlooked (or perhaps underpromoted) regional competitive advantage – a set of higher education institutions offering numerous distinguished programs in the visual and performing arts. The strength of these programs attracts students to the region, and their comparatively large enrollment results in a readily available, steady supply of graduates who represent an important source of replenishment of cultural talent in the region. Lastly, their physical presence in close proximity to key tourist attractions makes them an integral part of promoting the region as a tourist destination.

Thirty-six schools in the region offer majors in the visual and performing arts, with the top ten producing institutions accounting for more than three-quarters of the degrees conferred (Figure 15). Top producing majors lead graduates to careers in performance, organizational management and merchandising, and the commercial application of art (Figure 16). Many of these programs are among the best in their field, including six overall graduate programs and five graduate specialties that rank in the top 25 of their respective fields (Figure 17). Unlike in most fields of study, where the University of Pennsylvania's schools and programs account for almost all top-rankings for the region, three universities in addition to Penn have top-ranking visual and performing arts programs, rounding out the region's reputation as a major producer of quality cultural talent.

Figure 15.Top 10 Producing Greater Philadelphia Institutions in Visual and Performing Arts

	Total Graduates
1. Art Institute of Philadelphia	400
2. Temple University	350
3. The University of the Arts	200
4. University of Delaware	130
5. Antonelli Institute	120
6. University of Pennsylvania	110
7. Drexel University	100
8. Rowan University	80
9. Philadelphia University	80
10. West Chester University of Pennsylvania	70

Source: Pennsylvania Economy League (PEL) calculations based on data from the U.S. Department of Education, National Center for Education Statistics/Integrated Post-Secondary Education Data System (NCES/IPEDS), Completions, 1996-97

Figure 16. Top 10 Producing Majors by Greater Philadelphia Institutions in Visual and Performing Arts

	Total Graduates
1. Graphic Design, Commercial Art and Illustration	320
2. Art History, Criticism, and Conservation	180
3. Art, General	150
4. Music Business Management and Merchandising	130
5. Drama/Theatre Arts, General	120
6. Music, General Performance	100
7. Design and Applied Arts, Other	100
8. Fashion Design and Illustration	90
9. Photography	80
10. Music, General	80

Source: PEL calculations based on data from NCES/IPEDS, Completions 1996-97

Figure 17. Visual and Performing Programs Ranking in Top 25 (Masters of Arts) in Greater Philadelphia

Drama University of Delaware (10) Temple University (23)	**Fine Arts** Temple University (10) Painting Temple University (8) Photography Temple University (11) Sculpture Temple University (9)	**Music** Curtis Institute of Music (5) Opera/Voice Curtis Institute of Music (7) Orchestra/Symphony Curtis Institute of Music (5)
Film Temple University (9)	**Architecture** University of Pennsylvania (9)	

Source: U.S. News & World Report (website), 2001 Rankings of Graduate Programs

In the 1996-97 academic year, almost 2,100 students graduated from programs in the visual and performing arts offered by regional schools, the 6th largest group of visual and performing arts graduates in the country (Figure 18). While considerably more students graduate from visual and performing arts programs in other regions such as New York and Los Angeles, Greater Philadelphia produces 23 percent more graduates in visual and performing arts fields than the nation on average. In addition to graduates of visual and performing arts programs, each year regional schools also graduate 5,600 graduates from arts-related majors: liberal arts and general studies; English; foreign languages; architecture; and, area, ethnic and cultural studies (Figure 19).

Figure 18. Regional Comparison: Total Graduates from Visual and Performing Arts Programs

	Total Graduates
1. New York CMSA	8,250
2. Los Angeles CMSA	4,630
3. San Francisco CMSA	2,760
4. Boston CMSA	2,720
5. Chicago CMSA	2,270
6. Philadelphia CMSA	**2,060**
7. Washington-Baltimore CMSA	1,840
8. Dallas-Fort Worth CMSA	1,400
9. Detroit CMSA	1,260
10. Pittsburgh MSA	1,250

Source: PEL calculations based on data from NCES/IPEDS, Completions, 1996-97

Figure 19. Greater Philadelphia's Graduates from Arts-Related Majors

	Total Graduates
Liberal/General Studies & Humanities	3,360
English Language & Literature/Letters	1,290
Foreign Languages and Literatures	350
Architecture and related programs	320
Area, ethnic and cultural studies	240
Total, Arts-Related Majors	5,560

Source: PEL calculations based on data from NCES/IPEDS, Completions 1996-97

Not only are regional schools an important source of quality cultural talent for regional arts and culture organizations, but their campuses serve as a visible presence in the key tourist areas of Center City Philadelphia, particularly along the Avenue of the Arts. Six schools that produce graduates from the visual and performing arts are located in Center City and/or along the Avenue of the Arts, and five of these six schools are solely dedicated to art and music disciplines:

- The Art Institute of Philadelphia, the largest producer of visual and performance arts graduates in the region;
- The Curtis Institute of Music, considered one of the finest music conservatories in the world;
- The Moore College of Art and Design, the first and only women's college for the visual arts in the nation;
- The Pennsylvania Academy of the Fine Arts, the nation's oldest art museum and school; and,
- The University of the Arts, the largest comprehensive educational institution of its kind in the nation.

Temple University, which produces the second most graduates from visual and performing art majors and has numerous programs and specialties ranked in the top 25 of their respective fields, is located along the Avenue of the Arts North. Together, these six schools account for more than 50 percent of all graduates from visual and performing arts majors in the region.

Early Signs of Economic Success

While the full effect of regional investments and efforts in hospitality and tourism have yet to be realized, there is growing evidence that they are beginning to pay off – regional employment in the tourism and hospitality industry, for instance, grew by 12.1 percent or more than 13,600 jobs between 1995 and 1998, with the city itself gaining more than 5,400 jobs (Figure 20).[4] This employment pool is likely to continue increasing in size as regional institutions respond to this growing industry by designing programs that impart skills to future hospitality workers. Temple University has taken the lead in this vain – in 1998 it established the School of Tourism & Hospitality Management (affiliated with Temple's Fox School of Business and Management), which provides comprehensive education for management careers in sports and recreation, tourism, and hospitality.

Figure 20. Employment and Job Gains in the Hospitality Industry, 1995-1998

	EMPLOYMENT, 1998					
	Hotels and other lodging places (SIC 70)	Museums, botanical, zoo. gardens (SIC 84)	Amusement and recreation services (SIC 79)	Eating and drinking places (SIC 58)	Total Hospitality	Net Change, 1995-1998
Bucks	1,429	51	3,959	13,473	18,912	1,486
Chester	1,126	404	2,205	9,690	13,425	1,342
Delaware	1,311	208	2,452	11,465	15,436	1,250
Montgomery	2,503	43	5,330	21,800	29,676	4,153
Philadelphia	6,410	1,538	8,419	32,805	49,172	5,445
Total, 5 Counties	12,779	2,244	22,365	89,233	126,621	13,676

Source: PA Department of Labor & Industry

Just as important, other industries related to the visual and performing arts are being spun off from the strong presence of arts and culture in the region, such as the fledgling film production industry. The most successful efforts to build this industry to date have been those of the Greater Philadelphia Film Office, which is charged with marketing the region as a film location, steering crews through pre-production processes, and overseeing crews in town. Each year a growing number of film crews, including high profile productions, come to shoot at indoor and outdoor locations throughout the region. These productions provide business to local production companies and workers in the industry and draw positive media attention to the industry and the region itself. The future growth of this industry is tied to the successful citing of an off-site film production facility, which officials are attempting to locate at the foot of the Avenue of the Arts South. Similarly, a cluster of new media companies has sprouted in the midst of Old City, Philadelphia, a location that is not likely coincidental given it is the heart of the city's historical district. The new media industry is a major provider of content to the on-line, e-commerce world and, as such, benefits greatly from the supply of artistic talent generated by regional schools, many in close proximity to Old City.

Professional and Business Services

Technological innovations, particularly in information technology, are streamlining every aspect of the business process, from production to sales to accounting to marketing. These innovations are ushering in a host of entrepreneurial endeavors as new business ideas are hatched, while at the same time they are forcing "old economy" companies through tremendous change as they adapt to a new competitive environment. The challenges and opportunities facing companies in today's business world go beyond operational issues. Developments by universities and biotechnology firms have introduced entirely new debates over genetic testing and human cloning; hacking of computer systems is a constant threat to companies with Internet divisions and has raised concerns about privacy; e-commerce has made it more difficult to enforce local and state taxation; and the concept of intellectual property is being rewritten as companies go to court over the exclusive use of content, icons, and business models. These issues and more are keeping many entrepreneurs and business executives from sleeping, and so they turn to accountants, lawyers, consultants, programmers, advertisers, and others professionals to help them develop solutions. Greater Philadelphia's economic success depends on providing this type of support to businesses. In a world where first-mover advantage can often determine the difference between market leader and bankruptcy, having skilled professionals who are able to advise local startups on growth strategies and more established firms with adaptive strategies is crucial.

Fortunately, Greater Philadelphia's colleges and universities produce a substantial supply of graduates who have acquired professional skills that assist all kinds of businesses in adapting to the new economy. Almost 15,000 or about 30 percent of all degrees conferred in 1996-97 were earned in fields of study that support the business world – business management and administration; law; computer information sciences; and, engineering (Figure 21). Greater Philadelphia awards the 7th most degrees of these types in the country.

Figure 21. Regional Comparison: Total Graduates from Professional Services Fields of Study

	Business Mngmnt. & Admin. Svcs.	Law and Legal Studies	Computer Information Sciences	Engineering	Total Prof. Svcs. Degrees	GCI
1. New York CMSA	32,148	5,809	5,055	4,627	47,639	1.12
2. Los Angeles CMSA	15,752	2,151	1,627	3,377	22,907	0.85
3. Boston NECMA	14,958	2,681	1,427	3,783	22,849	1.18
4. Wash.-Balt. CMSA	11,753	3,599	2,784	3,191	21,327	1.20
5. Chicago CMSA	14,427	2,235	1,486	1,788	19,936	1.05
6. San Francisco CMSA	10,393	1,972	1,317	3,744	17,426	1.08
7. Philadelphia CMSA	**9,578**	**1,978**	**1,109**	**1,972**	**14,637**	**1.07**
8. Detroit CMSA	8,360	1,078	698	3,735	13,871	1.23
9. Dallas CMSA	6,394	502	805	804	8,505	1.09
10. Denver CMSA	4,817	631	751	1,550	7,749	1.20

Source: PEL calculations based on data from NCES/IPEDS, Completions 1996-97

The vast majority of these degrees are conferred in business management and administration, with more than 3,000 awarded for advanced studies (i.e., MBAs). Fifty institutions in the Philadelphia area grant degrees in business, however the Philadelphia region owes its reputation as a premier business location to the University of Pennsylvania's Wharton School, which is the "tallest tree" in terms of student enrollment and teaching quality. Wharton awards the most business degrees of all institutions, has the country's highest ranking undergraduate program and third-ranking program for graduate studies in business, and is responsible for all the top-25 rankings in business specialties that were awarded to Greater Philadelphia institutions (Figure 22). Penn also ranks in the top 25 for its law school and computer science programs, as well as in several specialties for these fields of study. In addition to imparting business skills to future professionals, three institutions – Penn, Temple University, and West Chester University – assist small business owners in the region by providing consulting services through Small Business Development Centers.

Figure 22. Professional Services Programs Ranking in Top 25 in Greater Philadelphia

Business – Graduate
University of Pennsylvania (3)
- Accounting
  - University of Pennsylvania (5)
- Finance
  - University of Pennsylvania (1)
- General Management
  - University of Pennsylvania (5)
- Management Info. Systems
  - University of Pennsylvania (8)
- International Business
  - University of Pennsylvania (3)
- Entrepreneurship
  - University of Pennsylvania (2)
- Marketing
  - University of Pennsylvania (2)
- Production/Operations
  - University of Pennsylvania (7)
- Quantitative Analysis
  - University of Pennsylvania (4)
- Non-Profit Organizations
  - University of Pennsylvania (2)
- Executive MBA
  - University of Pennsylvania (2)

Business – Undergraduate
University of Pennsylvania (1)

Law
University of Pennsylvania (12)
- Health Law
  - Widener U. – Del. Campus (9)
- Trial Advocacy
  - Temple University (1)
- Tax Law
  - University of Pennsylvania (24)
  - Villanova University (24)

Computer Science
University of Pennsylvania (25)
- Artificial Intelligence
  - University of Pennsylvania (8)

Engineering
- Bioengineering/Biomedical
  - University of Pennsylvania (9)
- Chemical
  - University of Delaware (9)
  - University of Pennsylvania (22)
- Materials
  - University of Pennsylvania (12)

Source: U.S. News & World Report (website), 2001 Rankings of Graduate and Undergraduate Programs

Graduates from law, computer science, and engineering programs also fill vital professional service positions in the region. While the region lacks the research dollars and high-ranking teaching programs in engineering-related fields of study, many of our computer information science programs graduate students at all levels of study (from associate's to doctorates) who go on to fill positions with management and computer consulting firms. Graduates from engineering programs have excellent opportunities to move into consulting positions in a range of fields, from planning to construction to environmental assessment. Graduates from law programs also find themselves with a wider range of possibilities, from starting positions with established law firms to consulting or senior-level positions with small but high-growth potential ventures. Graduates from fields of study related to business also contribute valuable skills to the region's worker pool, including programs in economics, library science, and communications. Several individual departments and programs stand out as being "top of the class" in their respective fields of study:

- **Drexel University's Graduate Program in Library Science.** The management and organization of information has taken on an increasingly important role in several industries and has elevated the profile of the librarian. Drexel University ranks 9th among library science programs in the country and is considered to have the nation's best information systems specialization. The school grants almost all of the 100 library sciences degrees conferred in the region.
- **Saint Joseph's University's Undergraduate Program in Food Marketing.** St. Joseph's Food Marketing program is the only wholly industry-supported academic program of its kind in the United States and just one of six nationally recognized programs related to the food industry. The department has garnered much acclaim from local and national businesses in producing graduates for this sector. The school grants as many as 100 business degrees in Food Marketing each year.
- **University of Pennsylvania's Economics Department.** Management consultants, marketers and other organizations that rely upon economic and financial research look to the area's colleges and universities to add new talent. The region awards an above average concentration in bachelor's and doctorate economics degrees. Of distinction is Penn's Economics Department, which ranks 9th among economics programs in the 2001 rankings issues *U.S. News & World Report*. Within the discipline, the

school has earned top-ten rankings in specialties such as industrial organization (9th), international economics (8th), macroeconomics (10th), microeconomics (9th), and public finance (9th).

Strong Connections to Philadelphia as a Premier Business Location

Our institutions' individual and collective strength in producing graduates equipped with business skills is reflected in (if not a reason for) the high level of professional services employment in the region – almost 100,000 people in the five counties of Southeastern Pennsylvania are employed in the professional services industries, accounting for about 6 percent of all regional employment (Figure 23).[5] Between 1995 and 1998, employment in professional services grew by more than 18,000 jobs. While all business students do not necessarily stay in the region upon graduation, accommodating such dramatic growth in regional professional services employment would not have been possible without the steady supply of home-grown talent produced by our regional institutions of higher education.

Figure 23. Employment and Job Gains in the Professional Services Industry, 1995-1998

	EMPLOYMENT, 1998					
	Legal Services (SIC 81)	Engineering & Mngmnt. Srvcs. (SIC 87)	Programming, Software Dev., & Sys. Integration (SIC 7371-73)	Advertising (SIC 731)	Total Professional Services	Net Change, 1995-1998
Bucks	1,255	6,095	825	327	8,502	1,231
Chester	1,238	6,960	4,392	484	13,074	3,075
Delaware	1,107	6,152	1,704	147	9,110	2,672
Montgomery	2,577	17,136	2,580	2,281	24,574	5,287
Philadelphia	17,231	24,139	948	1,659	43,977	5,869
Total, 5 Counties	23,408	60,482	10,449	4,898	99,237	18,134

Source: PA Department of Labor & Industry

The importance of providing this supply is illustrated by real world examples such as VerticalNet, a regional company that operates on-line business-to-business (B2B) sites for targeted industries. While VerticalNet is regarded as a market leader in B2B commerce (evident in the its highly successful initial public offering in 1999), VerticalNet is still shifting its industry exchanges from paper, which account for about half of all revenues, to on-line transactions. In order to complete this dramatic shift in industry transactional activity, the company recently announced it will need to hire workers for 1,000 newly created positions (in addition to the almost 700 people it currently employs locally and another 900 employed around the world). These positions, which include web designers, computer engineers, and customer-support staff, have average starting salaries of $55,000 and require skills typical of the professional service worker in today's high-tech economy. Mike Hagan, company cofounder and chief operation officer, publicly stated that his company intends to look to regional universities to help satisfy his company's need for high-tech, professional service workers and that they desire a close working relationship with regional institutions: "We really want to go in there and do grassroots-style recruiting by talking to the college deans."[6] The region's ability to meet this employment need is crucial for on-going and future economic success, as companies like VerticalNet have a good chance and the desire to become major employers that are identifiable with the region, such as Microsoft in Seattle.

Life Sciences Industries

Major technological advances are fundamentally changing life sciences industries, in particular the pharmaceutical industry and the health care delivery system (hospitals, physician practices, and outpatient care facilities). Stunning achievements such as the human genome project demonstrate the convergence of life sciences with information technology. This convergence is introducing a host of new possibilities in the life sciences industries, beginning with the way research and development is conducted to the method of delivering medical treatment and preventing illness and injury.

Just as engineering-based innovation has driven the high-tech, high-growth "new" economy of the past decade, so too is biology-based innovation expected to drive the next phase of the new economy, many experts believe. Peter Lange, Duke University Provost, explains this convergence of innovation eloquently:

> *It's very clear that this [genomics and related fields in the biological sciences] is the most dynamic area of science that's emerging. It's somewhat similar to the role that physics played in the middle of the last century in redefining so many areas of science. Genetics, genomics and the life sciences in general are very clearly going to play that same kind of catalytic role in the first 20 to 30 years of this century."*[7]

Of the ten "most strategic technological trends that will shape business and our world over the next 20 years," as issued by Battelle Memorial Institute, a science & technology think tank, four are life-sciences based: 1) genetic-based medical and health care; 2) nanomachines (microscopic size machines for localized drug delivery, for example); 3) designer food crops; and, 4) super senses (i.e., enhanced reality, as opposed to virtual reality).[8] Biology-based innovation not only promises to fundamentally alter existing life sciences industries, but also is expected to usher in entirely new industries. Many of these industries are still nascent fields of study that top university researchers and entrepreneurial R&D firms have undertaken. Emerging industries include bioinformatics, combinatorial chemistry, genetic engineering, and pharmacogenomics.[9]

Biology-Based Innovation and Regional Economic Competitiveness

As the race gets underway, many experts believe that much of biology-based innovation and subsequent economic growth will take place within regions. According to Collaborative Economics, life sciences are inherently innovative, knowledge-based industries, and as such are tied to social and placed-based settings. Regions by definition offer this type of setting.[10]

Regions with the ability to "absorb" biology-based innovation are likely to see it to commercial fruition, regardless of where this innovation originally emerged. Not surprisingly, however, not all regions are equipped or positioned to be successful in the biology-based new economy. According to Peter M. Pell, a consultant on bio-tech centers based out of Chapel Hill, NC: "…building a high-technology industry requires so much money and intellectual capital that there are only so many sites that can successfully put all of the pieces together."[11] Research evidence is beginning to bear this out – a case study completed by Case Western University, for example, found that intellectual property generated by university researchers in Detroit and Cleveland flowed out from these metro areas into high-tech regions such as Boston, San Francisco, and New York City, in spite of public and private investment.[12]

Which regions will be successful in the biology-based new economy? Collaborative Economics believes successful regions in the biology-based new economy will have five key ingredients: research excellence; a shared talent pool; access to capital; shared, specialized infrastructure; and, business & support services. What follows is an informal review of the ingredients present in the Greater Philadelphia region.

Large Pharmaceutical Companies

Perhaps Greater Philadelphia's greatest existing strength is the strong presence of pharmaceutical companies located in the region. According to the *Philadelphia Daily News*, 80 percent of the world's largest pharmaceutical companies have a presence in the area (headquarters, administrative offices, R&D facilities, and/or manufacturing operations).[13] As reported by Regional Financial Associates (RFA), the Philadelphia region has the 2nd highest level of regional employment in drug manufacturing in the country, with more than 22,000 employees.[14] Moreover, it is located in very close proximity to the Newark, NJ region, which has the highest drug manufacturing employment level in the country. The region's large pharmaceutical companies are complemented by a host of smaller firms that increasingly are taking on R&D functions. The Philadelphia region has the 8th highest employment level for R&D activity, according to RFA. (See Figure 24)

The presence of large pharmaceutical companies is an important regional ingredient for absorbing biology-based innovation. These companies are a primary source of talent for fledgling life-sciences firms that are seeking commercial applications for new discoveries. Often, employees from large pharmaceutical companies are the founders of small R&D firms themselves, and in some cases they are seeking to commercialize technology that failed to take hold in the bureaucratic setting of a large company. According to the head of one local biotech company, the ability to pick off talent from the large pharmaceuticals in the region was his primary reason for keeping his company local.[15]

Figure 24. Major Pharmaceutical and Biotechnology Companies in Greater Philadelphia

Company	Location	Type of operations
Bucks County, PA		
Quigley Corp.	Doylestown	Headquarters, research & development
Chester County, PA		
3-Dimensional Pharmaceuticals	Exton	Headquarters
Centocor**	Malvern	Headquarters, research & development
Cephalon	West Chester	Headquarters, research & development
Wyeth-Ayerst Pharmaceuticals✠	Malvern	Manufacturing
Delaware County, PA		
Astra-Zeneca Inc.*	Wayne	Astra headquarters, research & development
DuPont	Glenolden	Research & development
Endo Pharmaceuticals	Chadds Ford	Headquarters
Wyeth-Ayerst Pharmaceuticals✠	St. Davids	Headquarters, research & development
Montgomery County, PA		
Aventis Behring	King of Prussia	Headquarters
Cell Pathways Inc.	Horsham	Headquarters, research & development
Magainin Pharmaceuticals	Plymouth Meeting	Headquarters, research & development
McNeil Consumer Healthcare**	Fort Washington	Manufacturing, research & development
Merck & Co. Inc.	Horsham West Point	Administrative offices Manufacturing, research & development
Ortho McNeil Pharmaceuticals**	Spring House	Research & development
Rhone-Poulenc Rorer Inc.***	Collegeville	Research & development
SmithKline Beecham	Upper Providence	Research & development
New Castle County, DE		
Astra-Zeneca Inc.*	Wilmington	Zeneca headquarters, research & development
DuPont	Newark Wilmington	Research & development Headquarters, research & development
Philadelphia, PA		
SmithKline Beecham	Center City	Administrative offices
Salem County, NJ		
DuPont	Deepwater	Research & development

Source: Knox, Andrea, "For a SmithKline researcher, the real action is in the lab," The Philadelphia Inquirer, January 18, 2000 (table accompanying article). Note that numerous firms not on this list are located within an hour's driving distance of the region but are not officially part of the consolidated metropolitan area, such as the world headquarters of Johnson & Johnson in New Brunswick, NJ. *Astra's Wayne headquarters and Zeneca's Wilmington headquarters will be consolidated in Wilmington. **Division of Johnson & Johnson. ***Division of Aventis S.A.; operations will move to Bridgewater, NJ at the end of 2000 and name will change to Aventis Pharma. ✠Division of American Home Products Corp.

Pharmaceuticals themselves are major generators of biology-based innovation. SmithKline Beecham, whose headquarters are located in Center City Philadelphia, has recently been awarded patents for genetic and computer-derived biological data, molecular screening techniques, and drug design technology.[16] In another example of industry-led innovation, SmithKline Beecham scientists are taking the lead on a unique public-private collaboration to sequence the mouse genome. Experts believe the data describing the mouse genome, which upon completion will be made available for free via the internet, is a critical step toward understanding the human genome, whose sequencing was completed in early 2000.[17]

Large pharmaceutical companies are also an important source of capital for fledgling life-sciences firms – in 1998, industry provided $60 million or 9 percent of all R&D funding to research universities in the region.[18] Along with the federal government, industry provides substantial funding to nascent university research that it deems too risky to undertake itself. In spite of technological innovations, biology-based research is still a drawn-out and largely speculative process – for instance, years spent on medical research, product development, and clinical trials are no guarantee of federal drug approval. Because of this risk, larger companies are increasingly leveraging their research funding by building R&D capacity through collaborations with university research programs and smaller entrepreneurial firms. One of the strongest signs in favor of biology-based innovation has been recent high-profile acquisitions by large pharmaceuticals of smaller entrepreneurial firms, such as Johnson & Johnson's $4.9 billion purchase of Centocor Inc. (located in Malvern, Chester County, PA). Stepped up technology transfer activities are another favorable sign – almost a third of all currently active licenses and options were executed by regional universities in the most recent fiscal year alone.[19]

Universities and Academic Health Centers

Greater Philadelphia's research capacity ranks among the top 10 regions in terms of quantity and quality in life sciences research (biological, medical, agricultural, and other life sciences). In 1998, Greater Philadelphia had the 8th largest R&D expenditures for life sciences (Figure 25). As is the case with most regions, the life sciences dominate research in Greater Philadelphia – 74 percent of total regional expenditures went to life sciences in 1998, while no other field of study accounted for more than 7 percent of R&D expenditures. Within the broad field of life sciences, our strengths are $283 million in medical sciences research (6th largest) and $186 million in biological sciences research (5th largest).

Figure 25. Regional Comparison: R&D Expenditures in Life Sciences (Millions of Dollars)

	Medical Sciences	Biological Sciences	Agricultural Sciences	Other Life Sciences	Total Life Sciences*
1. New York CMSA	$578	$513	$32	$62	$1,184
2. San Francisco CMSA	$628	$68	$54	$1	$750
3. Wash.-Balt. CMSA	$473	$129	$27	$34	$663
4. Los Angeles CMSA	$431	$159	$24	$9	$623
5. Houston CMSA	$340	$188	$0	$11	$539
6. Raleigh-Durham MSA	$261	$189	$60	$17	$526
7. Boston NECMA	$210	$262	$0	$27	$498
8. Philadelphia CMSA	**$283**	**$186**	**$15**	**$12**	**$495**
9. Chicago CMSA	$275	$138	$0	$17	$429
10. Detroit CMSA	$269	$85	$3	$19	$375

Source: PEL calculations based on data from the National Science Foundation (NSF), Academic Research and Development Expenditures, Fiscal Year 1998 (early release tables). *Totals might not equal sum of sub-fields due to round-off error.

Greater Philadelphia's strength in the medical sciences is born out in rankings of graduate programs issued by *U.S. News & World Report* for 2001. Twenty-eight Greater Philadelphia graduate programs in life and related sciences rank in the top 25 of their respective fields, the 9th highest collective rankings in the country (Figure 26). Of this group of 28, 23 are in the medical sciences (medicine, veterinary medicine, and health disciplines). These rankings differ significantly from higher-ranking regions such San Francisco and Boston which have as many if not more top-ranking programs in the biological sciences than in medical programs. Our research excellence is largely dictated by Penn, the tallest tree among the region's colleges and universities. Penn is the second largest recipient of NIH funding in the country and accounts for 50 percent of R&D expenditures in Greater Philadelphia; has the largest research complex in the mid-Atlantic; and is home to almost all the top-ranking regional life science graduate programs.

Figure 26. Regional Comparison: Graduate Programs in Life and Related Sciences Ranking in Top 25

	Graduate Programs Ranking in Top 25 of Respective Fields				
	Biological Sciences	Medicine*	Health Disciplines	Related Life Sciences**	All Top-25 Rankings
1. New York CMSA	13	24	22	12	71
1. San Francisco CMSA	18	15	11	27	71
3. Boston NECMA	12	11	13	23	59
4. Raleigh-Durham MSA	4	18	14	7	43
5. Wash.-Balt. CMSA	7	9	17	5	38
6. Los Angeles CMSA	5	8	5	15	33
7. Seattle CMSA	2	10	13	7	32
8. Chicago CMSA	1	7	16	5	29
9. Philadelphia CMSA	**1**	**11**	**12**	**4**	**28**
10. Detroit CMSA	3	8	12	4	27

Source: PEL calculations based on data from U.S. News & World Report, 2001 Graduate Program Rankings. *Medicine consists of medical and veterinary medicine programs. **Related life sciences consists of chemistry, computer science, and bio(medical) engineering.

In addition to a strong research capacity, our colleges and universities provide a steady pool of worker candidates for regional employers, including new economy companies specifically seeking educated and skilled workers. According to John Tudor, chair of St. Joseph's University's Biology Department, candidates for entry-level positions in the pharmaceutical or biotech industries should have degrees in chemistry or biology and should be well-versed in molecular biology and computational sciences.[20] In the 1996-97 academic year, our institutions produced a significant supply of graduates with associate's and bachelor's degrees in life science and related fields, including average or above average concentrations of bachelor's degrees in agricultural sciences, biological sciences, bio/biomedical engineering, chemistry, and computer sciences and above average concentrations of associate's and bachelor's degrees in the health professions, as indicated by the graduate concentration index or GCI (Figure 27).[21]

Figure 27. Associate's and Bachelor's Degrees Conferred in Life Sciences Majors by Greater Philadelphia Institutes (Total Degrees Conferred & Graduate Concentration Index*, and Significant Producers)

	Total Degrees Conferred		GCI	
	Associates	Bachelors	Associates	Bachelors
Agricultural Sciences	9	248	0.59	1.46
Biological Sciences	18	1,428	0.48	1.03
Bio(medical) Engineering		52		2.53
Chemistry	2	263	0.37	1.13
Computer Sciences	291	549	1.51	1.03
Health Professions	2,133	2,555	1.24	1.38

Source: PEL calculations based on data from NCES/IPEDS, Completions, 1996-97

Familiarity with the regulatory environment of life sciences industries is a major advantage for any entry-level candidate. According to the CEO of a local biotech company, an entry-level worker with no prior experience typically undergoes 3-6 months of training.[22] Drexel University's co-op program and similar internship programs of other universities provide experience to regional life science graduates, resulting in significant cost savings for regional life science companies.

For workers in the pharmaceutical and biotech industries to move up through the ranks, they must have or obtain an advanced degree in their field, according to St. Joseph's Tudor. As with undergraduates, our colleges and universities produce a steady supply of graduates with advanced training – master's, doctoral, and first professional degrees (Figure 28). Our strongest area is in the health profession fields, where the concentration for all advanced degree types is above the national average, as indicated by the graduate concentration index (GCI). Our strongest concentrations of graduates come from bio(medical) engineering, chemistry, computers sciences (included as a related life science), and health professions.

Figure 28. Master's, Doctorate, and First Professional Degrees Conferred in Life Sciences Majors by Greater Philadelphia Institutions (Total Degrees Conferred & Graduate Concentration Index, and Significant Producers)

	Total Degrees Conferred			GCI		
	Master's	Doctorate	First Prof.	Master's	Doctorate	First Prof.
Agricultural Sciences	20	5		0.46	0.27	
Biological Sciences	141	103		0.81	0.80	
Bio(medical) Engineering	34	23		2.63	4.82	
Chemistry	54	58		0.89	0.96	
Computer Sciences	242	27		1.51	1.03	
Health Professions	1,329	77	1,673	1.38	1.07	1.23

Source: PEL calculations based on data from NCES/IPEDS (Completions, 1996-97)

As new opportunities emerge in the life sciences industries, our universities are beginning to offer programs combining advanced training in science and business to meet this growing demand. For example, Temple University recently announced a new master's program that provides training in cell biology and molecular techniques combined with business courses, internships with pharmaceutical companies, and training in federal regulatory requirements and compliance. Students who complete this program will have been prepared to work for a biotech or pharmaceutical company.[23] In order to facilitate this advanced training and to keep their workers, employers are increasingly offering tuition-reimbursement to such programs for workers who attend school at night.

One last area where universities make an important workforce contribution is in the training of physician-scientists – individuals who have a medical degree (MD) and/or a Ph.D. and perform biomedical research as their primary professional career. Physician-scientists, many of whom move into academic positions after their training and education, embody the earliest stage of the product development cycle in the life sciences where cutting-edge research is done. According to the Federation of American Societies for Experimental Biology, their role becomes all the more important as biology-based innovation becomes the basis of new economic growth: "As we enter the post-genomic era, physician-scientists will have the specialized perspectives required to lead evolving fields…As this research is translated into patient treatment protocols, it is physician-scientists who will have the necessary training and skills to ensure that these protocols are designed and evaluated in ethical and rigorous clinical trials."[24]

Five of Greater Philadelphia's six medical schools offer combined programs for MD/Ph.D.s, including the University of Pennsylvania, which has one of the largest programs in the country and receives significant support from the National Institutes of Health's Medical Scientist Training Program. This strength represents an important regional competitive advantage, given that in the past 20 years there has been a decline in the number of physician-scientists nationwide.[25] In general, the region is a major provider of advanced medical training – with six medical schools, two dental schools, two pharmacy schools, one school of veterinary medicine, and one optometry school, Greater Philadelphia confers the 3rd most first professional degrees in the health professions (after the New York and Chicago CMSAs).[26] Cross-disciplinary programs also generating the future leaders of emerging life sciences industries, such as the biomedical/bioengineering programs of the University of Pennsylvania and Drexel University, which together confer an above average concentration of advanced degrees in these fields (Figure 28).

Hospitals, Physician Practices, and Other Health Care Services

Health care services are one of the largest industries in the region, accounting for more than 206,000 workers or almost 12 percent of total employment in the 5 counties of Southeastern Pennsylvania in 1998 (Figure 29). As classified by the federal government, the health care services industry ranges from doctors' offices to hospitals to home health care services, with hospitals accounting for the most of the health cares services employment in the region (47percent).

Figure 29. Employment and Job Gains in the Health Services Industry, 1995-1998

	EMPLOYMENT, 1998							
	Doctors' Offices & Clinics (SIC 801-804)	Nursing & Personal Care Facilities (SIC 805)	Hospitals (SIC 806)	Medical & Dental Labs. (SIC 807)	Home Health Care Srvcs. (SIC 808)	Other Health Services (SIC 809)	Total Health Services	Net Change, 1995-1998
Bucks	6,587	5,628	6,996	685	781	1,203	21,880	1,358
Chester	5,268	3,209	6,211	136	972	1,014	16,810	1,576
Delaware	7,207	6,060	9,835	544	1,217	694	25,557	449
Montgomery	15,078	8,915	16,225	3,545	4,407	1,797	49,967	5,653
Philadelphia	13,368	11,431	58,100	673	2,952	5,113	91,637	(417)
Total, 5 Counties	47,508	35,243	97,367	5,583	10,329	9,821	205,851	8,619

Source: PA Department of Labor & Industry

The health care services community is likely sharing its talent pool with emerging life sciences companies, especially as the former undergoes major industrial restructuring. According to the Pennsylvania Economy League, Greater Philadelphia's health care industry is characterized by hospitals with overcapacity and declining occupancy rates. Furthermore, the region's academic health centers have comparatively high health costs due to the severity of patient cases treated in tertiary care institutions and a declining support base of their respective medical and research capacities.[27] These cost pressures are forcing tremendous change throughout the region's health care delivery system, particularly for hospitals, the largest employers of the health care system, and physician practices by extension.

Health care workers who are pushed out or elect to leave the health care system represent an interesting workforce pool for emerging life sciences companies. Many of these workers have a baseline set of skills that with strategic retooling would allow them to transition into emerging life sciences industries. For example, nurses who are tired of providing "bedside" care are excellent candidates for filling regulatory compliance or sales positions with pharmaceutical or biotech companies.[28] Similarly, doctors who elect to leave clinical practice can likely play a role in the medical research world. Our colleges and universities, which already provide much of the training to the region and country's health care workers, could play a key role in transitioning these workers into new positions with emerging life sciences companies.

In addition to being a major regional employer, the health care services industry engages in basic and applied research and facilitates clinical research trials, an important step in the R&D process. Strong ties exist between the regional health care system and academic R&D – of the five top research universities in Greater Philadelphia, four are or include an academic health center (Thomas Jefferson University, MCP Hahnemann University, the Hospital of the University of Pennsylvania, and the Health Sciences Center of Temple University). As the health care industry undergoes restructuring, repositioning hospital facilities as dedicated research infrastructure is a possible opportunity for regional life sciences companies and future economic growth.

Competition for the Life Sciences

As the new economy moves into the next phase of biology-based innovation, the challenge for the Philadelphia region is to act fast and decisively because other states and regions have already committed to and invested heavily in economic development initiatives that aim to capitalize on emerging life sciences industries. Some recent examples of initiatives (proposed and underway) are:

- **North Carolina.** North Carolina State University in Raleigh has built Centennial Park, a mixed used research campus ($340 million in development to date) that is intended to rival Research Triangle Park. It also has recently launched master's and doctoral degree programs in genomics. UNC-Chapel Hill has committed $100 million to expand its genomics research capabilities. And Duke University is considering spending $200 million on its Institute for Genome Sciences and Policy, a multi-disciplinary research center.
- **California.** Governor Davis of California has proposed appropriating $75 million to create "Institutes for Science and Innovation" at different campuses of the University of California system. These

institutes are intended to spur on new industries in close proximity to UC campuses. UC San Francisco is completing a new medical research center along the city's waterfront that is expected to result in significant economic impact for the city, including the creation of 10,000 to 20,000 indirect private sector jobs in support of the universities research activities.

- **Michigan.** Michigan is undertaking a 20-year, $1 billion initiative to cultivate large clusters of new businesses involved in bioengineering and other emerging life sciences industries. Research conducted at three institutions – Michigan State University, University of Michigan, and Wayne State University – will be the basis for this bold initiative.

The list of proposals goes on and on; indeed, most states and even some regions appear to be considering economic development goals that involve university research in some manner. Greater Philadelphia's challenge is to bring together the pieces that already exist and build them into something greater.

Regional Opportunities and Challenges: Biology-Based Economic Growth

Many of the ingredients needed to be successful in the emerging life sciences industries are present in Greater Philadelphia, representing key opportunities for future economic growth. However, Collaborative Economics is quick to point out that ingredients only go so far unless there is a "recipe." Elements of a successful remedy include: a vibrant entrepreneurial culture; specialization; collaboration; and, networks.

According to Collaborative Economics, most regions fall into one of three stages of development with regard to biology-based innovation: 1) regions will all the ingredients and recipe; 2) regions with a niche ingredient and niche recipe; and, 3) regions with limited ingredients and daunting recipe. The evidence suggests that Greater Philadelphia has many of the prerequisite ingredients, though not necessarily a recipe or even a "chef" to follow the recipe. Furthermore, whether our ingredients add up to overall regional strength in the life sciences or amount to a niche strength is not clear.

The region should be asking and answering these basic questions regarding its competitive position in the emerging life sciences industries. The stakes are high and the competition stiff as other regions that are larger, stronger, and/or more ambitious have already made significant investments in their respective industries. As summed up by Mike Fogerty, Professor at the Weatherhead School of Management at Case Western Reserve University in Cleveland and an expert on the economics of technology: "Philadelphia has a fantastic asset in its industrial laboratories…There are other places that would love to have what Philadelphia has. The question is how Philadelphia can take advantage of this technology, because if you don't, somebody else will."[29]

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[1] Parter International, Inc. (Prepared for The Pew Charitable Trusts), Philadelphia Tourism: Assessment, Analysis & Recommendations (Volume I), July 14, 1995, p. 20.
[2] Pennsylvania Economy League (PEL), Greater Philadelphia's Competitive Edge: The Nonprofit Culture Industry and its Economic Value to the Region, May 1998, p.5.
[3] Avenue of the Arts, Inc. Extending the Vision for South Broad Street: Building Philadelphia's Avenue of the Arts in the 21st Century, October 1999.
[4] The hospitality industry is based on the industry cluster defined by Greater Philadelphia First (GPF) in its 1999 Regional Economic Benchmarking Report.
[5] For the purposes of this analysis, professional services industries are broadly defined as establishments that render services to business establishments on a contract or fee basis. Note that this definition for professional services differs slightly from the definition established by GPF for the Professional Services Cluster discussed in its Regional Economic Benchmarking report. GPF's Professional Services Cluster includes three more industry sub-sectors: educational services, membership organizations, and manufacturing admin.
[6] Hill, Miriam, "Pa. helps company to add tech jobs," The Philadelphia Inquirer, September 27, 2000.
[7] Kane, Dan, "Colleges bank on science," News-Observer, April 2, 2000.
[8] Battelle Memorial Institute, "Battelle forecasts strategic technologies for 2020," November 30, 1999.
[9] Definitions of these fields provided by the Pharmaceutical Research and Manufacturers Association and the Foundation for Genetic Medicine (http://genomics.phrma.org/lexicon/index.2.html): 1) Bioinformatics is the science of informatics as applied to biological research. (Informatics is the management and analysis of data using advanced computing techniques.) Bioinformatics is particularly important as an adjunct to genomics research, because of the large amount of complex data this research generates. 2) Combinatorial chemistry is a technique for rapidly and systematically assembling a variety of molecular entities, or building blocks, in many different combinations, to create tens of thousands of diverse compounds that can be tested in drug discovery screening assays to identify potential useful candidates. 3) Genetic engineering is the altering the genetic material of cells or organisms in order to make them capable of making new substances or performing new functions. 4) Pharmacogenomics is the science of understanding the correlation between an individual patient's genetic make-up (genotype) and their response to drug treatment.

Some drugs work well in some patient populations and not as well in others. Studying the genetic basis of patient response to therapeutics allows drug developers to more effectively design therapeutic treatments.
[10] Collaborative Economics, Networks of Innovation: Regions Collaborating to Compete in the Global Market (presented at the National Gathering of Biotech/Life Science Innovation Regions, BIO2000 Conference), March 27, 2000.
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[12] Florida, Richard, "The Role of the University: Leveraging Talent, Not Technology," Issues in Science and Technology (Online), Summer 1999.
[13] Angeles, Mark, "Biotechnology taking root," The Philadelphia Daily News, February 29, 2000.
[14] RFA data is for the 9-county Philadelphia, PA-NJ PMSA.
[15] Know, Andrea, "Industry's Profile: High-tech but low-key," The Philadelphia Inquirer, September 28, 1997, L01.
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[18] National Science Foundation (NSF), Academic Research and Development Expenditures, Fiscal Year 1998 (early release tables).
[19] Association of University Technology Managers (AUTM), FY1998 Licensing Survey.
[20] Archbold, Matt, "Science Training Pays Off at Area Firms," The Philadelphia Inquirer, February 27, 2000, p. H01.
[21] The Graduate Concentration Index (GCI) is the ratio of degrees conferred in each field of study as a proportion of all degrees conferred in the region to the nation's proportion. A GCI of 1.00 demonstrates that the concentration of degrees conferred in a given field of study in the region is greater than the US average. A GCI greater than 1.00 is above average concentration, while a GCI below 1.00 is below average concentration.
[22] Archbold, 2000.
[23] Archbold, 2000.
[24] Zemlo, Tamara R., et. al (Office of Public Affairs, Federation of American Societies for Experimental Biology), "The Physician-Scientist: Career Issues and Challenges at the Year 2000," Life Sciences Forum, Vol. 14, February 2000, pp. 221-230.
[25] Zemlo, 2000.
[26] First professional degrees in the health professions are awarded in: medicine (MD), dentistry (DDS, DMD), osteopathic medicine (DO), veterinary medicine (DVM), podiatry (DPM, DP, or PodD), optometry (OD), and pharmacy (Bpharm, PharmD).
[27] PEL, Greater Philadelphia's Challenge: Capitalizing on Change in the Regional Health Care Economy, February 1996.
[28] Archbold, 2000.
[29] Fernandez, 1999.

APPENDIX A: GREATER PHILADELPHIA'S COLLEGES AND UNIVERSITIES

Research/Doctoral Universities

Private, non-profit
1. Drexel University[4]
2. MCP Hahnemann University[1]
3. University Of Pennsylvania[4]

Public, state-related
4. Temple University[3]
5. University of Delaware

Comprehensive Universities

Private, non-profit
6. Beaver College
7. Cabrini College[2]
8. Chestnut Hill College
9. Eastern College[2]
10. Gwynedd Mercy College
11. Immaculata College
12. La Salle University[3]
13. Philadelphia University[3]
14. Saint Josephs University[2]
15. Villanova University[2]
16. Widener University - Delaware Campus
17. Widener University - Main Campus
18. Wilmington College

Public, state
19. Cheyney University Of Pennsylvania
20. Rowan University
21. Rutgers University-Camden
22. West Chester University Of Pennsylvania

Public, state-related
23. Lincoln University

Liberal Arts Colleges

Private, non-profit
24. Bryn Mawr College[2]
25. Delaware Valley College
26. Gratz College
27. Haverford College[2]
28. Holy Family College
29. Neumann College
30. Rosemont College[2]
31. Swarthmore College[2]
32. Ursinus College

Public, state
33. The Richard Stockton College of New Jersey

Associate of Arts Colleges

Private, non-profit
34. Harcum College[2]
35. Manor Junior College
36. Peirce College[1]
37. Pennsylvania Institute Of Technology
38. Valley Forge Military College[2]

Public, county/local
39. Atlantic County College
40. Bucks County Community College
41. Burlington County College
42. Camden County College
43. Cecil Community College
44. Community College Of Philadelphia[1]
45. Cumberland County College
46. Delaware County Community College
47. Delaware Technical & Comm. College - Wilmington
48. Gloucester County College
49. Montgomery County Community College
50. Salem Community College

Private, for-profit
51. Antonelli Institute[1]
52. Art Institute Of Philadelphia
53. CHI Institute
54. CHI Institute - Rets Campus
55. Churchman Business School
56. Lansdale School Of Business
57. Lincoln Technical Institute
58. PENNCO Tech

Medical Schools/Centers, Other Health Professional Schools

Private, non-profit
59. Pennsylvania College Of Optometry[3]
60. Pennsylvania College Of Podiatric Medicine[1*]
61. Phila. College Of Osteopathic Medicine
62. Thomas Jefferson University[1]
63. University of the Sciences in Philadelphia[4]

Public, state
64. University Of Medicine & Dentistry - Camden Campus, Stratford Campus

Other schools

Private, non-profit

65. Biblical Theological Seminary
66. Curtis Institute Of Music[1]
67. Eastern Baptist Theological Seminary
68. Goldey-Beacom College
69. Lutheran Theological Seminary At Philadelphia
70. Moore College Of Art And Design[1]
71. Pennsylvania Academy of Fine Arts[1]
72. Philadelphia College Of Bible
73. Reconstructionist Rabbinical College
74. Saint Charles Borromeo Seminary - Overbrook
75. The University Of The Arts[1]
76. Valley Forge Christian College
77. Westminster Theological Seminary

Public, state-related

78. Pennsylvania State University - Great Valley

Not Classified

Public, state

79. NJ Institute of Technology - Mt. Laurel Campus

Public, state-related

80. Penn State Univ. - Abington College
81. Penn State Univ. - Delaware County Campus of the Commonwealth College

Private, for-profit

82. Computer Learning Center, Inc.[4]
83. The Restaurant School[4]

Cluster listings

1 Center City Cluster
2 Main Line Cluster
3 North Philadelphia Cluster
4 University City Cluster

* The Pennsylvania School of Podiatric Medicine was a separate institution at the time most of the data presented in this report was captured. Note that is recently has been incorporated into Temple University as the School of Podiatric Medicine.

Greater Philadelphia's Top-Producing Fields of Study by Degree Level: Number of Degrees Conferred and Graduate Concentration Index (GCI)

All Degree Levels Top-Producing Fields of Study	**Degrees Conferred**	**GCI**
Business Management & Administrative Services	9,580	1.02
Health Professions & Related Sciences	7,770	1.36
Education	5,380	1.03
Social Sciences and History	3,410	1.04
Liberal/General Studies & Humanities	3,360	0.69
Associate's Degrees Top-Producing Fields of Study	**Degrees Conferred**	**GCI**
Liberal/General Studies & Humanities	2,770	0.89
Health Professions & Related Sciences	2,130	1.24
Business Management & Administrative Services	1,380	0.83
Visual and Performing Arts	630	2.69
Engineering-Related Technologies	420	0.72
Bachelor's Degrees Top-Producing Fields of Study	**Degrees Conferred**	**GCI**
Business Management & Administrative Services	5,090	1.05
Social Sciences and History	2,980	1.11
Health Professions & Related Sciences	2,560	1.38
Education	2,390	1.04
Psychology	1,710	1.07
Master's Degrees Top-Producing Fields of Study	**Degrees Conferred**	**GCI**
Business Management & Administrative Services	3,060	1.18
Education	2,500	0.85
Health Professions & Related Sciences	1,330	1.38
Public Administration and Services	680	1.03
Engineering	610	0.88
Doctoral Degrees Top-Producing Fields of Study	**Degrees Conferred**	**GCI**
Education	240	1.30
Engineering	140	0.82
Psychology	120	1.11
Social Sciences and History	110	1.01
Biological Sciences/Life Sciences	100	0.80
First Prof. Degrees Top-Producing Fields of Study	**Degrees Conferred**	**GCI**
Health Professions & Related Sciences	1,670	1.23
Law and Legal Studies	1,540	0.90
Theological Studies/Religious Studies	160	0.62

Source: NCES/IPEDS, Completions 1996-97. Based on completions reported for 81 institutions.

APPENDIX B: INSTITUTION RANKINGS

U.S. News & World Report **2001 Rankings of Greater Philadelphia Institutions**

UNDERGRADUATE INSTITUTIONAL RANKINGS

Undergraduate National University - Tier 1
University of Pennsylvania (7)

Undergraduate National University - Tier 2
University of Delaware

Undergraduate National University - Tier 3
Drexel University
MCP Hahnemann University
Temple University

Undergraduate National Liberal Arts - Tier 1
Swarthmore College (1)
Haverford College (5)
Bryn Mawr College (18)

Undergraduate Regional (Northern) University - Tier 1
Villanova University (1)
Saint Joseph's University (13)
La Salle University (17)
Beaver College (20)
Rutgers University at Camden (23)
Gwynedd-Mercy College (36)
Widener University (36)

Undergraduate Specialty – Business
University of Pennsylvania (1)
University of Delaware (77)
Villanova University (93)

Undergraduate Specialty - Engineering With Ph.D.
University of Pennsylvania (28)
Drexel University (46)
University of Delaware (52)

Undergraduate Specialty - Engineering Without Ph.D.
Swarthmore College (9)
Villanova University (13)
Widener University (41)

Undergraduate Specialty – Pharmacy
University of The Sciences In Philadelphia (22)

GRADUATE & FIRST PROFESSIONAL PROGRAMS

Business (MBAs)

Business (Overall)
University of Pennsylvania (3)

Business - Accounting
University of Pennsylvania (5)

Business - Finance
University of Pennsylvania (1)

Business - General Management
University of Pennsylvania (5)

Business - Management Information Systems
University of Pennsylvania (8)

Business - International Business
University of Pennsylvania (3)

Business - Entrepreneurship
University of Pennsylvania (2)

Business - Marketing
University of Pennsylvania (2)

Business - Production/Operations Management
University of Pennsylvania (7)

Business - Quantitative Analysis
University of Pennsylvania (4)

Business - Non-Profit Organizations
University of Pennsylvania (7)

Business - Executive MBA
University of Pennsylvania (2)

Law (JDs)

Law (Overall)
University of Pennsylvania (12)

Law - Health Law
Widener University-Delaware Campus (9)

Law - Trial Advocacy
Temple University (1)

Law - Tax Law
University of Pennsylvania (24)
Villanova University (24)

Medicine (MDs)

Medicine (Overall)
University of Pennsylvania (3)

Medicine - Primary Care
University of Pennsylvania (24)

Medicine - Osteopathy
Philadelphia College Of Osteopathic Medicine

Medicine - Women's Health
University of Pennsylvania (3)
MCP Hahnemann University (14)

Medicine – Geriatrics
University of Pennsylvania (9)

Medicine - Internal Medicine
University of Pennsylvania (6)

Medicine – AIDS
University of Pennsylvania (10)

Medicine - Drug/Alcohol Abuse
University of Pennsylvania (5)

Medicine - Family Medicine
Thomas Jefferson University (19)

Medicine – Pediatrics
University of Pennsylvania (2)

Veterinary Medicine
University of Pennsylvania (2)

Engineering

Engineering (Overall)
University of Pennsylvania (33)
University of Delaware (47)

Engineering - Bioengineering/Biomedical
University of Pennsylvania (9)

Engineering – Chemical
University of Delaware (9)
University of Pennsylvania (22)

Engineering - Electrical/Electronic/Communications
University of Pennsylvania (28)

Engineering – Materials
University of Pennsylvania (12)

Education

Education (Overall)
University of Pennsylvania (11)
Temple University (20)

Education - Social/Philosophical Foundations
University of Pennsylvania (17)

Education - Elementary Teacher Education
University of Pennsylvania (22)

Education - Higher Education Administration
University of Pennsylvania (21)

Ph.D. Programs

Biological Sciences (Overall)
University of Pennsylvania (23)

Chemistry (Overall)
University of Pennsylvania (20)

Computer Science (Overall)
University of Pennsylvania (25)

Computer Science - Artificial Intelligence
University of Pennsylvania (8)

Economics (Overall)
University of Pennsylvania (9)

Economics – Microeconomics
University of Pennsylvania (9)

Economics – Macroeconomics
University of Pennsylvania (10)

Economics - Industrial Organization
University of Pennsylvania (9)

Economics - International Economics
University of Pennsylvania (8)

Economics - Public Finance
University of Pennsylvania (9)

English (Overall)
University of Pennsylvania (11)
Temple University (54)

English - Medieval Literature
University of Pennsylvania (12)

English - Renaissance Literature
University of Pennsylvania (4)

English - 19th- and 20th-Century British Literature
University of Pennsylvania (5)

English - 19th- and 20th-Century American Literature
University of Pennsylvania (13)

English - African-American Literature
University of Pennsylvania (2)

English - Gender and Literature
University of Pennsylvania (14)

History (Overall)
University of Pennsylvania (12)
University of Delaware (58)

History - Modern US History
University of Pennsylvania (14)

History - US Colonial History
University of Pennsylvania (5)

History - European History
University of Pennsylvania (13)

History - Women's History
University of Pennsylvania (11)

History - African-American History
University of Pennsylvania (4)

History - Cultural History
University of Pennsylvania (16)

Math (Overall)
University of Pennsylvania (21)

Math - Geometry/Topology
University of Pennsylvania (9)

Physics (Overall)
University of Pennsylvania (18)

Political Science (Overall)
University of Pennsylvania (39)

Psychology (Overall)
University of Pennsylvania (9)
University of Delaware (62)
Temple University (71)

Psychology - Clinical Psychology
University of Pennsylvania (8)

Psychology - Experimental Psychology
University of Pennsylvania (7)

Psychology - Developmental Psychology
University of Pennsylvania (13)

Sociology (Overall)
University of Pennsylvania (12)

Sociology - Social Stratification
University of Pennsylvania (8)

Nursing

Nursing (Overall)
University of Pennsylvania (2)
Villanova University (59)
University of Delaware (70)
Thomas Jefferson University (103)
La Salle University (124)
Temple University (124)

Nursing Service Administration
University of Pennsylvania (2)

Nurse Practitioner - Family
University of Pennsylvania (4)

Nurse Practitioner - Adult
University of Pennsylvania (1)

Nurse Practitioner - Pediatric
University of Pennsylvania (4)

Nurse-Practitioner - Gerontological/Geriatric
University of Pennsylvania (1)

Clinical Nurse Specialist - Adult/Medical-Surgical
University of Pennsylvania (2)

Clinical Nurse Specialist - Psychiatric/Mental Health
University of Pennsylvania (2)

Other Health Disciplines

Audiology
Temple University (49)

Community Health
Temple University (19)

Health Services Administration
University of Pennsylvania (4)
Temple University (26)

Physical Therapy
University of Delaware (9)
Beaver College (9)
Temple University (15)
Thomas Jefferson University (28)
MCP Hahnemann University (28)
Rutgers University at Camden (61)
University of The Sciences In Philadelphia (74)

Physician Assistant
Beaver College (26)

Social Work
University of Pennsylvania (11)
Bryn Mawr College (19)
Temple University (58)

Speech/Language Pathology
Temple University (30)

Fine Arts

Fine Arts (Overall)
Temple University (10)
University of The Arts (29)
Pennsylvania Academy of The Fine Arts (45)
University of Pennsylvania (55)
University of Delaware (89)

Fine Arts - Painting/Drawing
Temple University (8)

Fine Arts – Photography
Temple University (11)
Fine Arts – Sculpture
Temple University (9)

Music

Music (Overall)
Curtis Institute Of Music (5)
Temple University (30)
University of The Arts (73)
University of Delaware (86)

Music - Opera/Voice
Curtis Institute Of Music (7)

Music - Orchestra/Symphony
Curtis Institute Of Music (5)

Music - Piano/Organ/Keyboard
Curtis Institute Of Music (5)

Other Arts

Architecture
University of Pennsylvania (9)

Creative Writing
Temple University (50)

Drama
University of Delaware (10)
Temple University (23)

Film
Temple University (9)

Public Affairs

Public Affairs (Overall)
University of Pennsylvania (36)
University of Delaware (52)
Rutgers University at Camden (99)

Public Affairs - City Management/Urban Policy
University of Delaware (7)

Public Affairs - Health Policy & Management
University of Pennsylvania (14)

Public Affairs - Nonprofit Management
University of Pennsylvania (15)

Public Affairs - Public Finance and Budget
University of Pennsylvania (16)

Public Affairs - Public Management/Admin
University of Delaware (26)

Public Affairs - Public Policy Analysis
University of Pennsylvania (29)

Library Science

Library Science
Drexel University (9)

Library Science - Information Systems
Drexel University (1)

APPENDIX C: NOTES ON METHODOLOGY

Regional Institution Counts

Institutions were identified using data provided by the National Center for Education Statistics' (NCES) through the Integrated Post-Secondary Education Data System (IPEDS). Specifically, "completions" data (i.e., degrees conferred) from the academic year 1996-97, the most recent year for which data was available, was used. Institutions were included in the regional count according to the following criteria:

1) they conferred degrees of bachelor's or higher; or,
2) they conferred at least 25 associate's degrees.

All institutions that satisfied these criteria were included in the final count for Greater Philadelphia and comparison regions, including instances were multiple branch campuses of the same institution were coded separately in the IPEDS data set (e.g., Widener University-Main Campus and Widener University-Delaware Campus).

Several adjustments were made to the Greater Philadelphia count. Two New Jersey institutions were added to the list – the University of Medicine and Dentistry, Camden Campus & Stratford Campus (counted as one institution) and the New Jersey Institute of Technology, Mt. Laurel. Both these institutions are campuses of New Jersey universities with main campuses in other parts of the state. However, campus-level data was not available for either of these institutions in the IPEDS systems so they are not reflected in other regional measures such as total enrollment or expenditures data. Two other points of clarification: MCP Hahnemann was counted as a separate institution even though Drexel University took over management after the bankruptcy of the Allegheny Health Education and Research Foundation. Also, the Pennsylvania School of Podiatric Medicine was counted as a separate institution, even though it recently has been incorporated into Temple University as the School of Podiatric Medicine.

In several instances Greater Philadelphia is compared to five other regions for a more narrow analysis: 1) Boston-Worcester-Lawrence-Lowell-Brockton, MA-NH NECMA, which is most similar to Philadelphia in age and industry breakdown; 2) Houston-Galveston-Brazoria, TX CMSA, comparable in population size; 3) Pittsburgh, PA MSA, Pennsylvania's other major metropolitan region who can be viewed as an in-state competitor and collaborator; 4) Raleigh-Durham-Chapel Hill, NC MSA, a fast-growing high tech economy that is generally acknowledged as having strong ties to colleges and universities; and, 5) San Francisco-Oakland-San Jose, CA CMSA (i.e., Silicon Valley), unequivocally the focal point of high-tech activity in the country today. All are knowledge industry competitors of Greater Philadelphia, especially in the growing industry of biotechnology.

All regions mentioned in this report are reported as either: 1) the Consolidated Metropolitan Statistical Areas (CMSA); 2) the Metropolitan Statistical Area (MSA); or the New England County Metropolitan Area (NECMA). The US Office of Management and Budget has defined these regional designations according to published standards that are applied to Census Bureau data. In this report, regions are reported as the largest existing geographic designation. If a region is part of a CMSA, it is reported as part of the CMSA. For example, Greater Philadelphia is reported as the Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD CMSA (unless otherwise noted), which is comprised of 14 counties spread out among three Primary Metropolitan Statistical Areas (PMSAs). On the other hand, Pittsburgh, PA, is reported as an MSA because it is not part of a larger CMSA. Unless otherwise noted, rankings cited throughout this report are a comprehensive mixture of CMSAs, MSAs, and NECMAs.

Gross Regional Product

Greater Philadelphia's gross regional product (calculated for the 9-county Philadelphia, PA-NJ region) was estimated by first calculating the percentage of industry employment, at the two-digit level, as a proportion of total state employment in the respective industry (e.g., the number of manufacturing jobs in the MSA as a proportion of total state manufacturing jobs). The percentage was then multiplied by the total gross state product (obtainable from the US Bureau of Economic Analysis) for the respective industry. Once this figure was calculated for each industry, the totals were aggregated to compute a gross regional product. Gross regional product was calculated for two years, 1990 and 1996, and adjusted to reflect real dollars. Average annual growth between 1990 and 1996 is intended to convey a sense of the region's economic value and output. This methodology rests on the assumption that output per employee is uniform statewide.

Estimates of Student Attraction

The total number of students from the 5 Pennsylvania counties of the metropolitan area was estimated using 1997-98 first-time enrollment data provided by the Pennsylvania Department of Education. This report includes data on the original state of residence of students enrolling for the first time in each regional institution. Estimates from New Jersey, Delaware, and Maryland regional institutions were estimated from first-time enrollment data reported by the National Center for Education Statistics. From both these data sets, the percentage of students from Pennsylvania, New Jersey, Delaware, and Maryland were calculated for each institution. The number of students from the 14-county metro area was carved out of the PA/NJ/DE/ME figure according to the following assumptions: 1) private, highly selective schools drew the smallest number of "native" students as a proportion of total institutional enrollment; 2) less selective private schools, state schools, and state-related schools drew a much higher number of native students as a proportion of total institutional enrollment; and, 3) all PA/NJ students of enrolling at community colleges and private, proprietary institutions were assumed to be originally from the region. These estimates were used to determine the number of students who originally were not from the region. Eleven institutions with the greatest number of students coming from outside the region were contacted for feedback on the estimates for the 9-county region. Eight of the 11 institutions provided feedback, which was incorporated into the final estimates.

Regional Strategic Economic Clusters

In 1995, Greater Philadelphia First put forth an economic strategy identifying five industry clusters that present the greatest growth opportunities for the region or are of strategic importance to the region. These five industry clusters represent opportunities not only for regional employment growth, but also for regional economic growth because they are tradable or exportable industries. Growth in these industries draws in dollars from outside the region that boost wages, create more jobs, raise the skill levels of workers, and ultimately generate wealth for the region. The following industries make up the strategic economic clusters:

Professional Services: Engineering and management services; educational services; membership organizations; manufacturing admin. and auxiliary; legal services; computer programming services; computer integrated systems design; advertising; prepackaged software

Hospitality: Eating and drinking places; amusement and recreation services; hotels and other lodging places; museums, botanical, zoological gardens

Data-Intensive Services: Business services; insurance carriers; printing and publishing; depository institutions; insurance agents, brokers, and service; non-depository credit institutions; catalog and mail-order houses

Health Care Services and Products: Health services; drugs; surgical, medical, & dental instruments and support; ophthalmic goods

Manufacturing: precision manufacturing sub-cluster; heavy manufacturing sub-cluster; processing industries sub-cluster; other manufacturing sub-cluster

Estimates of Net Gain/Loss of College-Bound People

First-time freshmen enrollment for 1998-99 was estimated using the growth rate between 1992-93 and 1996-97 of the IPEDS data set. (First-time freshmen enrollment data for 1998-99 is currently not available.) Data on the post-graduation intentions of high school graduates in the Philadelphia region (public and private) for the 19997-98 school year was obtained from the Pennsylvania Department of Education and the *Philadelphia Inquirer's* School Report Card. The post-graduation intentions of New Jersey, Delaware, and Maryland regional high school graduates were estimated using data from the Philadelphia portion of the region. Similar data was obtained for four comparison regions from their respective state Departments of Education, however several could not provide data on private high school graduates. Private school graduates from these regions were estimated based on the ratio of private high school graduates throughout each respective state as reported by the National Center for Education Statistics. No data on the number or post-graduation intentions of high school graduates could be provided for the San Francisco CMSA and therefore this region was excluded from this comparison. The final measure is the difference between the total number of college-bound high school graduates in each region and total first-time freshmen enrollment at regional institutions.

Higher Education Quality Index

The index of higher education quality is a regional indicator that was developed by the *Pittsburgh Post-Gazette* using the *U.S. News & World Report* rankings. The index, which has been expanded from the original *Post-Gazette* measure to include more of the *U.S. News* rankings, grants points to regions based on the number of institutions that appear in the top rankings according to the following criteria:

Graduate & First Professional Programs	Undergraduate Institutions
• Top 25 law school – 10 points • Top 25 medical school – 10 points • Top 25 business school – 10 points • Top 25 Engineering Ph.D. program – 3 points • Top 25 Chemistry Ph.D. program – 3 points • Top 25 Physics Ph.D. program – 3 points • Top 25 Biological Sciences program – 3 points • Top 25 Computer Sciences Ph.D. – 3 points	• First tier (top 50) national undergraduate university – 8 points • Second tier national undergraduate university – 5 points • Top 40 liberal arts college – 3 points • Third tier national undergraduate university – 1 point • Tier 1 regional undergraduate university – 1 point

This methodology to some degree addresses the most controversial aspect of the *U.S. News* rankings – the claim that the ranking criteria have not been consistent from year to year. This inconsistency has resulted in significant changes in the positions of the top-ranking institutions. In the methodology of the Higher Education Quality Index, points are awarded based on whether or not the institution was top-ranking, as opposed to awarding points based on the actual ranking of each institution.

Faculty Awards

Faculty Awards were assembled by the University of Florida's TheCenter as part of its research on The Top American Research Universities (http://thecenter.ufl.edu/). Data were collected from directories or web-based listings for multiple agencies or organizations on several prominent grant and fellowship programs in the arts, humanities, science, engineering, and health fields. Data were aggregated at the regional level by PEL. Faculty awards included in this measure are:

- American Council of Learned Societies (ACLS) Fellows, 1998-99
- Beckman Young Investigators, 1999
- Burroughs-Wellcome Fund, 1999
- Cottrell Scholars, 1999
- Fulbright American Scholars, 1999-00
- Getty Scholars in Residence, 1999-00
- Guggenheim Fellows, 1999
- Howard Hughes Medical Institute Investigators, 1998-99
- Lasker Medical Research Awards, 1999
- MacArthur Foundation Fellows, 1999
- National Endowment for the Humanities (NEH) Fellows, 1999-00
- National Humanities Center Fellows, 1999-00
- NIH MERIT (R37) and Outstanding Young Investigator (R35), FY 1999
- National Medal of Science and National Medal of Technology, 1999
- Newberry Library Long-term Fellows, 1999-00
- Pew Scholars in Biomedicine, 1999
- Presidential Early Career Awards for Scientists and Engineers (PECASE), 1998
- Robert Wood Johnson Policy Fellows, 1998-99
- Searle Scholars, 1999
- Sloan Research Fellows, 1999
- NSF CAREER awards (excluding those who are also PECASE winners), 1998
- US Secretary of Agriculture Honor Awards, 1999
- Woodrow Wilson Fellows, 1999-00

As noted by TheCenter: "While the vast majority of these programs clearly identify a particular campus, in a few instances we used the institution's web-based phone directory to determine the correct campus."

Estimates of Regional Educational Attainment Level

Regional educational attainment levels were estimated using county figures from the 1990 Census as the base and adjusting them with 1997 national figures from the Census Bureau's Current Population Survey. The underlying assumption of the methodology is that changes in US educational levels and population between 1990 and 1997 were proportional to changes in educational levels and population at the county level over the same period. County estimates were calculated in the following manner: The percentage change in US educational level between 1990 and 1997 was calculated. This figure was then divided by the percentage change in the 25+ population over the same period to obtain a ratio. On the county side, the percentage change in the 25+ population was calculated for the same period. The next step was to solve for the unknown percentage change in educational attainment at the county level and aggregating the county estimates to obtain a regional educational attainment level. These estimates were combined with total student enrollment at regional institutions to come up with a proxy for the pool of skilled and educated workers in the region. The final measure is the ratio of this pool of skilled workers to the regional working age population, defined to be the resident population ages 16 to 64 years.

GREATER PHILADELPHIA'S KNOWLEDGE INDUSTRY

Part II: Competing for Knowledge

Prepared by the Pennsylvania Economy League – Eastern Division

Fall 2000

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On behalf of the project's sponsors, I am pleased to present a collection of reports on *Greater Philadelphia's Knowledge Industry*. Our purpose in undertaking this project was to profile the region's colleges and universities, with the goal of gaining a better understanding of this important regional asset and how it contributes to Greater Philadelphia's economic competitiveness. This goal has led to numerous recommendations for strengthening our knowledge industry, including specific strategies that aim to forge stronger ties between our colleges and universities and the regional economy. The ultimate success of this project, however, will be measured by the report's ability to bring together the region's academic, business, civic, and political communities under a shared vision for our region's future.

In completing this project, we have collected a significant amount of data to profile and benchmark Greater Philadelphia's knowledge industry, allowing for regional comparisons that form an important backdrop describing the global competitive environment. Much of this data was obtained from the National Center for Education Statistics (NCES), which maintains a wealth of data on higher education institutions throughout the country in the Integrated Post-Secondary Education Data System (IPEDS). As you will see, the NCES/IPEDS data set forms the backbone of our research. Many colleges and universities in the Philadelphia region also willingly provided data and insight during the research process, an invaluable complement to the NCES/IPEDS data set. Qualitative insight was gathered from notable sources on higher education, in particular the *Chronicle of Higher Education*, the *Philadelphia Inquirer* and the *Philadelphia Daily News* (for local higher education insight), and various academic publications in the fields of public policy, economics, and higher education administration. Finally, a number of individuals representing the academic, business, and civic sectors in the region previewed the draft research findings, providing important feedback on content and presentation.

Thanks and much deserved recognition go to the following organizations and individuals for their help and assistance throughout the project:

- The Pew Charitable Trusts, through Jim England and Don Kimelman, provided generous initial funding for the project as well as valuable guidance throughout the research phase.
- The University of Pennsylvania, the City of Philadelphia's Commerce Department, and the Pennsylvania Department of Community and Economic Development (DCED) provided generous matching funds for the project as well as valuable guidance throughout the research phase. In particular, John Fry, Jack Shannon, and Anne Taufen of the University of Pennsylvania; Jim Cuorato of the City Commerce Department and former Commerce Director Stephen Mullin; and Tim McNulty of DCED are to be recognized for their contributions.
- More than 60 academic, civic, and business leaders in the region took time to preview the draft research findings, providing valuable feedback on content and presentation.
- The University City Science Center provided initial assistance in organizing the project.
- Lastly, officials of other regions, most notably Baltimore, Boston, Pittsburgh, and the San Francisco Bay Area, graciously hosted the research team during benchmarking visits and provided valuable insight into their regions' knowledge industry initiatives.

The research presented in these reports represents the collective work of PEL Research Associates Annette Goldberg and Ernie Wright, under the guidance of Executive Director David Thornburgh and Deputy Director and Research Director Steve Wray and with the assistance of Research Associate Andrew Maleson and former Research Associate Anuj Gupta. A copy of the report is available on our website: www.peleast.org. We invite your thoughts on this research – please e-mail, call, or write us with your comments.

David B. Thornburgh
Executive Director
Pennsylvania Economy League–Eastern Division

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PHILADELPHIA'S POSITION AS A KNOWLEDGE REGION

Increasingly, the quality and success of its higher education assets will define Greater Philadelphia's economic position. The region's ability to provide employers with a high quality workforce, to generate the ideas necessary to build new products and companies, and to compete in the emerging life sciences industries depend upon its knowledge industry. However, we are not the only place trying to claim leadership in the new knowledge-based economy. Thus, it is crucial to understand how we stack up and how we are perceived, and the implications and challenges those rankings and perceptions present. This section puts Philadelphia's performance in context with its competitors – the largest knowledge regions in the country. In some areas we stack up well. In others, we have work to do.

The Southern Technology Council (STC) provides a useful description of the new economy. According to STC, in the new economy:

- Economic growth is tied to technology.
- Technological advances will enable global economic activity.
- Entrepreneurial companies play a key role through their product innovation and aggressive pursuit of international markets. And,
- These companies will pay a high premium for highly trained and knowledgeable people and even base their location decisions on where they have access to pools of these workers.[1]

A growing body of evidence convincingly demonstrates that a strong, vibrant knowledge industry of colleges and universities is a vital component for regional economic success in the new economy. By attracting students to the region, colleges and universities provide an entry-point for individuals and an important source of population growth for the region. By providing access to an educated and skilled workforce, colleges and universities support the employment needs of regional employers. These employers include fast-growing new economy companies that are willing to relocate their businesses in order to have access to an educated workforce. And by generating innovation, university research lays the seeds for future economic growth through licensing agreements and start-ups formed to explore the commercial potential of research findings.

In the "old" economy, company location decisions were largely driven by regional business costs, such as taxes or tax incentives, unemployment compensation, land and office space, and energy costs. In this competitive environment colleges and universities played an important role in terms of generating new knowledge and producing an educated workforce, but their role had less direct bearing on company location decisions. In the new economy, advances in computer and information technology have supplanted labor-intensive operations and lessened the importance of physical place, in the process driving down traditional business costs. By freeing up businesses from the constraints of traditional business costs, technological advances have in essence rendered "…knowledge, skills and experience embodied in individuals [more valuable] than capital equipment or even capital itself."[2]

The Role of the Knowledge Industry in the New Economy

As evidence for the increasing importance of the new economy grows, so too does the evidence demonstrating its importance in regional growth. In an exhaustive study of the high-tech economy and its impact on metropolitan areas, the Milken Institute estimated that their level of high-tech activity could explain 65 percent of the difference

in economic growth in the 1990s between regions. What accounted for regional differences in high-tech activity? According to the Milken report, research centers and institutions, which include colleges and universities, were "…undisputedly the most important factor in incubating high-tech industries."[3] In a more qualitative analysis of the high-tech economy, the *New York Times* reported that "localized boomlets" of high-tech activity can be found all over the country and what they all have in common is a research university nearby.[4] In his "entrepreneurial climate test," researcher David Birch cites universities as a "hard determinant" of a region's entrepreneurial climate.[5] As described by Richard Florida, a Carnegie Mellon professor of regional economic development:

> *"The university becomes more critical than ever as a provider of talent, knowledge, and innovation in the age of knowledge-based capitalism. It provides these resources largely by conducting and openly publishing research and by educating students. The university is powered in this role by generating new discoveries that increase its eminence. In this way, academic research differs markedly from industry [research and development], which is powered by the profit motive and takes place in an environment of secrecy."*[6]

As traditional cost factors become less important in businesses' location decisions, a region's ability to provide employers access to a knowledgeable workforce will be directly tied to job and wealth creation. The value of these workers is such that companies will pay a premium for them and base location decisions on them. Mike Emmi, CEO of SCT Corporation, a Greater Philadelphia information technology company, explained matter-of-factly the importance of workers to *Inquirer* business columnist Andy Cassel: "Our business is an intellectual property-based business. We'll go wherever we need to go to find the brains. If that is India, we'll go to India. If it's Russia, we'll go to Russia."[7]

Jason Olim, co-founder and President & CEO of CDNow, an on-line music retailer based in Fort Washington, PA, expressed a similar sentiment though in a different context: "The value in [CDNow] is not in the facility; it's not in the computers; there's no capital assets here to buy. The value of this business is in the people who are here – the cohesiveness and the culture of the organization."[8] Because companies will locate where pools of workers live, quality of life factors such as weather, leisure opportunities, and cost of living will become more important in attracting and retaining companies.

Who will these knowledge workers be? They will be cutting-edge researchers who make exciting new discoveries that improve existing products or processes. They will be smart go-getters who hatch new business ideas using newly available technology and maybe even start high-tech companies where they want to live. And they will be workers with technical skills and know-how who fuel the employment growth of new economy companies. Colleges and universities are a magnet for these kinds of people – students, faculty, and researchers. In the new economy, colleges and universities truly become the *knowledge industry* because their primary output is both knowledge and knowledge workers.

Philadelphia's Position as a Knowledge Region

The Milken Institute study presents comprehensive evidence that regional economic success is increasingly tied to strong levels of high-tech activity. Strong levels of high-tech activity, in turn, are bolstered by the presence of colleges and universities in regions. In spite of this conclusion, the same study did not report a significant level of high-tech activity in the Greater Philadelphia region, which placed 15th among the 50 largest metropolitan areas in the country.[9] Of the 14 high-tech industries analyzed in the Milken report (9 manufacturing industries and 5 service industries), Greater Philadelphia had only four industries for which high-tech activity was greater than the nation on average. The region's high-tech performance stood in marked contrast to other regions with a strong presence of colleges and universities – Boston, for instance, ranked 4th in the study and had better-than-average activity in 11 of the 14 high-tech industries.

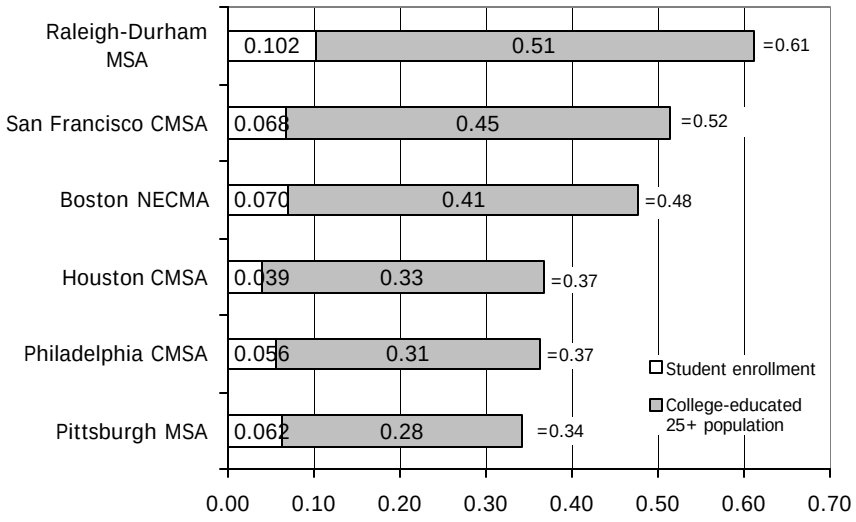
For years, the Philadelphia region's higher education assets have been touted as being leading factors in the future economic success of the region. Yet the region's economic and demographic statistics are disconnected from what should be an important regional advantage. Despite the number of students graduating from the region's colleges and universities, the region is aging and its educational attainment levels are surprisingly low. The region's economy has not seen the growth in new business starts or employment growth that has been characteristic in other knowledge regions, particularly in the booming information technology fields. The conclusions of the Milken study regarding Greater Philadelphia's performance in the new economy introduce an interesting conundrum: With its base of educational assets, why has the region underperformed the leaders in these crucial measures of economic competitiveness? Three reasons stand out:

- The region has a comparatively small pool of educated and skilled workers;
- The region has a slow growing, aging population;
- The region has been hampered by a lack of entrepreneurial activity.

Comparatively Small Pool of Educated and Skilled Workers

The importance of company access to an educated and skilled workforce is highlighted in David Birch's entrepreneurial "climate test," which incorporated it into the following question that regions must ask of themselves: "Are innovative companies able to recruit nearly all their professional workforce from the local area?"[10] While no region-wide employer survey asking this question has been completed, its answer can be inferred from rough estimates of what the region's pool of educated and skilled workers might be. According to these estimates, the ratio of Greater Philadelphia's immediately accessible worker pool – made up of total student enrollment and college-educated workers ages 25 and older[11] – to the working-age population is smaller than what is found in a number of Philadelphia's competitor regions (Figure 1). In the case of Raleigh-Durham, for instance, a strong presence of college students and residents with a college education offer employers a substantial pool of educated and skilled workers. These estimates suggest that, while the region surely has a greater pool of educated and skilled workers than many other regions because of our colleges and universities, the ties between the regional economy and the knowledge industry are not as strong as in other regions.

Figure 1. Regional Comparison: Ratio of Educated and Skilled Worker Pool to Working-Age Population*



Source: Pennsylvania Economy League (PEL) estimates of educational attainment based on 1990 & 1997 census figures (refer to Appendix C: Notes on Methodology); the US Department of Education, National Center for Education Statistics (NCES), Integrated Post-Secondary Education Data System (IPEDS), Enrollment Fall 1997. *Educated and skilled worker pool is defined as the sum of total full-time equivalent (FTE) enrollment (i.e., full-time students + 1/3 part-time students) and the 25+ population with a college degree. The working age population is defined as the population ages 16-64. Note: This chart is not a comprehensive ranking of regions.

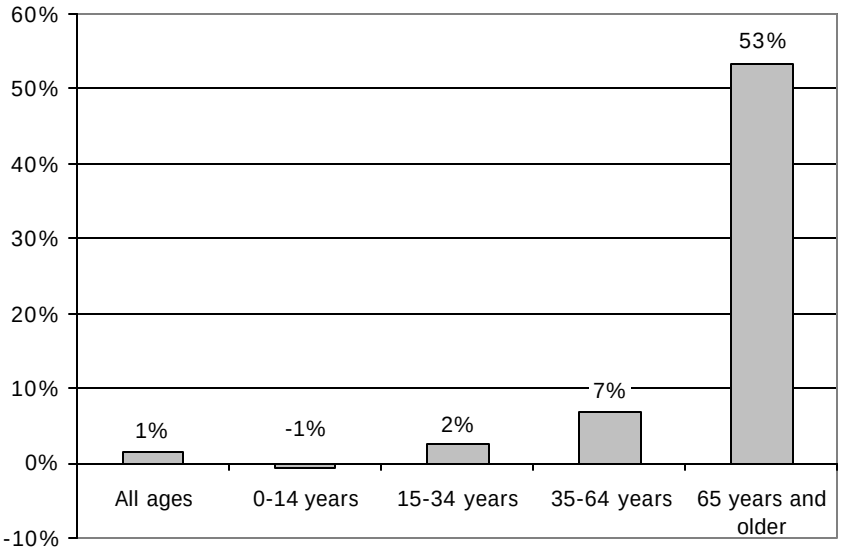
The region's comparatively small pool of educated and skilled workers has likely already hampered employment opportunities. Greater Philadelphia First (GPF), in its 1999 annual report of Regional Economic Benchmarks, reported that the region ranked 43rd of the 50 largest metropolitan areas with employment growth of only 5 percent between 1991 and 1997. In a measure of income opportunity, the region ranked 44th among the same group of metro areas, down from 43rd the previous year.[12]

Slow-Growing, Aging Population

While one of the largest metropolitan areas in the country, Greater Philadelphia as a whole has experienced relatively little population growth in the past decade, as reported by the Regional Workforce Partnership in its *Workforce 2000* report. Foreign and net domestic migration that are fueling population growth in other regions has

been markedly low in Greater Philadelphia. Young people between the ages of 18 and 35 as a group have declined in number in recent years, while the older population is the only age group projected to experience significant growth well into the 21st century (Figure 2). As stated in the *Workforce 2000* report: "These trends are partly attributable to differences in generation size and longer life expectancies, but they also suggest that many young people are not coming to or staying in the region."[13] These distressing demographic trends suggest that the region is not taking full advantage of an asset that is a magnet for not just people, but knowledge workers.

Figure 2. Regional Population Projections by Age Group, Percent Change Between 1997 and 2025



Source: Delaware Valley Regional Planning Commission (as reported by the Regional Workforce Partnership in Workforce 2000: An Annual Report on Greater Philadelphia's Labor Market). *Note: Data is reported for the 8 counties that make up DVRPC's service area (Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties in PA; Burlington, Camden, and Gloucester Counties in NJ.)

Lack of Entrepreneurial Activity

The ability of any region to absorb the innovation generated by local universities is also a critical factor in generating local economic growth. In a study of universities in Detroit and Cleveland, researchers found that intellectual property generated by these universities flowed to high-tech regions such as Boston, San Francisco, and New York City.[14] Much of this outflow of ideas can be attributed to a lack of an entrepreneurial climate in a region; in particular a lack of locally based venture capital and a dearth of management talent with experience leading high-growth companies. As summed up by Florida in his study of universities: "In short, the university is a necessary but not sufficient condition for regional economic development."[15]

Numerous studies of the Philadelphia region have pointed out the lack of an entrepreneurial climate or have left it out entirely in rankings of regional high-tech clusters. David Birch's study of entrepreneurial "hot spots" ranks the Greater Philadelphia region 44th among the 50 largest metropolitan areas in the country in terms of entrepreneurial climate. Birch's rankings are based on "…the actual, recorded frequency with which new firms start[ed] and young firms [grew] in different places."[16] Greater Philadelphia First's 1999 benchmarking report, which uses the location of venture capital firms as a proxy for entrepreneurial activity, cites only two major venture capital firms with headquarters in the Greater Philadelphia region, compared with 25 in Silicon Valley, 22 in Boston, and nine in New York. The lack of a regional entrepreneurial climate is perhaps the greatest threat facing the region in the race to be a leader in biology-based innovation – if vital ingredients for nurturing fledgling start-ups are absent, our university-generated ideas are likely to flow out of the region.

The Region's Knowledge Industry Challenge: Moving Out of the Second Tier

Philadelphia's lackluster performance as a center of advanced technology raises concerns about whether the region has slipped as a center of the knowledge industry. This concern is valid. Comparisons to other regions point out that despite Greater Philadelphia's historic leadership in higher education, it is clearly in a second tier of knowledge

regions. Regions like Boston and the San Francisco Bay Area are at the top of the class in terms of quantity and quality, while aggressive regions like Raleigh-Durham, San Diego and many others are striving to climb higher. All of this says that we need to do a better job of connecting our knowledge industry to our broader economy and making sure that the region stays competitive in a hyper-competitive climate.

Without continual investment and a more focused regional approach to growing and improving the region's knowledge industry, the region risks slipping further into the second tier – jeopardizing both future economic success and the reputations and caliber of its higher education institutions. The region must focus on three key challenges if it is going to stay in the vanguard of leading knowledge regions and improve its national reputation and ranking as an exciting center for new technology and company development:

- Talent attraction – Is the region bringing in enough students to meet the current and future needs of our economy and fuel future economic innovation?
- Quality and reputation – Are regional institutions acknowledged as leaders in research and teaching quality?
- Innovation generation – Are the region's institutions capable of competing with the nation's leaders for key research talent and research funding and translating that base of funding and talent into new economic growth?

Talent Attraction: Fueling Current and Future Economic Growth in the Knowledge Economy

Student Concentration: Is Philadelphia Really a "Collegetown"?

While Greater Philadelphia's knowledge industry has enough students to qualify as the 3rd largest city in Pennsylvania, our student population is not as large as might be expected given our overall population size (the 6th largest CMSA in the country) and in comparison to other regions. In a ranking of the 20 metropolitan regions with the largest student populations, Greater Philadelphia's full-time equivalent student enrollment ranks 7th (Figure 3).[17]

Figure 3. Regional Comparison: Total Full-Time Equivalent (FTE) Enrollment and Regional Population Rank

	Total FTEs	Ranking, 1998 Population
1. New York CMSA	703,800	1
2. Los Angeles CMSA	535,700	2
3. Chicago CMSA	321,600	3
4. San Francisco Bay Area CMSA	309,800	5
5. Boston NECMA	268,800	7
6. Washington-Baltimore CMSA	264,500	4
7. Philadelphia CMSA	**213,400**	**6**
8. Detroit CMSA	173,800	8
9. Dallas CMSA	137,700	9
10. San Diego MSA	128,400	17
11. Seattle CMSA	127,900	13
12. Houston CMSA	113,100	10
13. Phoenix MSA	108,000	14
14. Minneapolis-St. Paul MSA	104,800	16
15. Denver CMSA	104,000	19
16. Atlanta MSA	102,700	11
17. Miami CMSA	98,500	12
18. Pittsburgh MSA	91,600	20
19. Cleveland CMSA	83,800	15
20. Austin MSA	80,400	41

Source: PEL calculations based on data from NCES/IPEDS, Enrollment Fall 1997; US Census Bureau (1998 population figures)

As with New York, Los Angeles, and Chicago, large student populations tend to be a function of large population size, but not in all cases. San Diego, for instance, is the 17th largest metropolitan area in the country but its student population is the 10th largest, and Austin's student population ranking is twice as high as its overall regional population ranking. If Greater Philadelphia's student population was the same proportion of total US student enrollment as the region's population was to the total US population, our student population would be larger by almost 20,000 more students (full-time equivalent).

Even when regional population size is held constant, Greater Philadelphia's student population is comparatively less dense than what is commonly believed. Among the same group of 20 regions with the country's largest student populations, our region ranks 12th in terms of concentration (i.e., FTE enrollment per 1,000 regional residents). If the Philadelphia region drew the same concentration of students as leading competitors, we would have thousands more students than we do today (Figure 4). For instance, if Philadelphia's concentration (35.6 FTEs per 1,000 residents) of students matched Pittsburgh's (39.0 FTEs per 1,000 residents), we would have at least 20,000 more FTE students. If we matched the concentration of the Denver CMSA (44.0 FTEs per 1,000 residents), we would have almost 50,000 more FTE students. And if we reached Boston's concentration of 45.8, our student population would be larger by about 61,000 FTE students.

Figure 4. Regional Comparison: Concentration of Student Population (FTE Enrollment Per 1,000 Regional Residents) for 20 Largest Knowledge Regions

	FTEs/1000 Residents
1. Austin MSA	72.7
2. San Diego MSA	46.2
3. Boston NECMA	45.8
4. San Francisco Bay Area CMSA	45.5
5. Denver CMSA	44.0
6. Pittsburgh MSA	39.0
7. Seattle CMSA	37.4
8. Minneapolis-St. Paul MSA	37.0
9. Phoenix MSA	36.8
10. Chicago CMSA	36.5
11. Washington-Baltimore CMSA	36.3
12. Philadelphia CMSA	**35.6**
13. New York CMSA	35.1
14. Los Angeles CMSA	33.9
15. Detroit CMSA	31.8
16. Cleveland CMSA	28.8
17. Dallas CMSA	28.7
18. Atlanta MSA	27.4
19. Miami CMSA	26.9
20. Houston CMSA	25.7

Source: PEL calculations based on data from NCES/IPEDS, Enrollment Fall 1997; US Census Bureau (1998 population figures)

Bringing Students to the Region

The concentration of student populations in regions clearly highlight the importance of student attraction – some of the largest regional student populations in the country have comparatively low concentrations of students, including the Philadelphia region. Regions whose student populations are comparatively concentrated have attracted enough students from outside the region such that they *more* than offset the group of college-bound graduates from regional high schools who leave the area for school. In the 1997-98 school year, an estimated three-fourths of graduates from high schools in the Philadelphia region (about 43,400 students) indicated their intention to enroll in college the 1998-99 academic year. When this group is compared to the estimated number of *freshmen* enrolling for the first time at regional institutions in the 1998-99 academic year, the region appeared to have a net gain of 3,000 college-bound individuals.[18]

In the context of regional population growth, this net gain is important – the 14-county consolidated region grew 2 percent or an average annual net gain of 12,100 between 1990 and 1998, while the city of Philadelphia had average

annual net *losses* in population of 18,700 over the same period.[19] However, Greater Philadelphia's gain in college-bound individuals is smaller than what is found for other regions and might help explain why the region drops in rankings of student enrollment concentration (Figure 5). By the same token, a net gain of almost 15,000 students in the Boston metropolitan area is not surprising given that the region ranks 3rd among the 20 largest student populations in terms of concentration. The fact that Boston in particular is a net gainer of college-bound young people was confirmed by a 1992 US Department of Education study, which found that 6 of the 10 states having the greatest student in-migration for college were in New England.[20]

Figure 5. Regional Comparison: Net Gain/Loss of College-Bound People

	College-bound high school students from region	Total first-time freshmen enrollment at regional institutions	Regional net gain/loss of college-bound people
Boston NECMA	37,900	52,500	+14,600
Raleigh-Durham MSA	6,900	12,000	+5,100
Philadelphia CMSA	43,400	46,400	+3,000
Pittsburgh MSA	18,300	18,900	+600
Houston CMSA	31,600	25,300	-6,300

Source: PEL calculations based on data from respective State Departments of Education and NCES/IPEDS, Enrollment Fall 1997; PEL estimates of 1998-99 first-time freshmen enrollment. Refer to Appendix C: Notes on Methodology for an explanation of the methodology used to calculate the net gain/loss in college-bound young people. Note: This chart is not a comprehensive ranking of regions.

A smaller-than-expected regional student population (in absolute terms and in terms of concentration) is not likely a symptom of unfilled, excess capacity at individual institutions. The challenge of recruiting students and meeting capacity is surely an on-going one as fluctuations in student population are not uncommon. But there is little evidence that the collective effort of individual institutions to recruit students is insufficient to fill classrooms – the regional student population grew by 5,300 students (actual students, not FTEs) in the 1990s.[21] Furthermore, strong growth in university employment and expenditures, especially compared to general measures of regional economic growth, suggests that the industry is not severely hampered by excess capacity.

State officials confirm that excess capacity does not exist in Southeastern Pennsylvania's state schools to the extent that it does in other parts of Pennsylvania, where declining populations of young people have been troublesome. The State System of Higher Education, which oversees state schools in Pennsylvania, has allowed institutions with demonstrated excess capacity to lower their out-of-state tuition for students from select neighboring states in an effort to boost enrollment. Of Greater Philadelphia's two fully funded state institutions, West Chester University is reportedly filled to capacity and Cheyney University has demonstrated only slight excess capacity. While Cheyney University has opted to selectively reduce out-of-state tuition, the majority of institutions participating in the program are from other parts of the state where significant excess capacity has been demonstrated.

A more likely explanation of the lower-than-expected collective student population stems from the fact that the region's colleges and universities are predominantly private and small. Seventy-two of our 83 institutions have 5,000 or fewer students (FTEs) and only one institution has more than 20,000 (FTEs). Unlike other competitor regions, the city of Philadelphia – the core of this region's knowledge industry – does not have a large, fully funded state university. (Temple University receives only a portion of its funding from the state.) Rather, our fully funded state schools are located in the outer reaches of the region. Branches of the state's largest public institution, Penn State, which like Temple University is only partially funded by the state, are two-year suburban campuses that primarily feed into the main campus in Central Pennsylvania.[22]

In comparison to Boston and the San Francisco Bay Area, Greater Philadelphia not only has fewer colleges and universities, but fewer larger universities (i.e., at least 5,000 students). And even though Greater Philadelphia has more institutions then most regions, our largest institutions do not constitute the critical mass of students as is the case in other regions, such as San Francisco (Figure 6). Some of the most prominent schools in the region, namely our top-ranking liberal arts colleges, are especially small – Bryn Mawr College (1,800 students), Haverford College (1,100 students), and Swarthmore College (1,400 students). As older, place-based institutions primarily located in built-out areas, this region's colleges and universities perhaps lack the space and mobility to grow that companies in other industries have.

Figure 6. Regional Comparison: No. of Institutions (in Parentheses), Five Largest Institutions (Total FTEs), and Total Enrollment (FTEs) for Select Regions

Philadelphia CMSA (83)	San Fran. Bay Area CMSA (102)	Boston NECMA (103)
1. Temple University..... 21,200	1. UC-Berkeley..... 28,500	1. Boston University..... 25,600
2. University of PA 18,900	2. SF State University..... 20,900	2. Harvard University 20,100
3. University of DE 17,600	3. San Jose State Univ.... 20,400	3. Northeastern Univ..... 17,900
4. West Chester U of P..... 9,400	4. City College of SF 14,100	4. U. of NH-Main Camp... 12,600
5. Comm College of Phila. . 8,800	5. Stanford University..... 13,700	5. Boston College 12,600
TOTAL FTEs 213,400	TOTAL FTEs..... 309,800	TOTAL FTEs.....268,800
Houston CMSA (33)	**Pittsburgh MSA (48)**	**Raleigh-Durham (14)**
1. U of Houston-U. Park.. 23,600	1. Univ. of Pittsburgh 21,300	1. NC State U.-Raleigh.... 22,400
2. Houston CC System.... 19,400	2. CC of Allegheny Co..... 10,100	2. UNC-Chapel Hill..... 21,300
3. N. Harris Mont. CC 11,700	3. Duquesne University.....7,700	3. Duke University 11,300
4. Texas Southern Univ.... 6,300	4. Carnegie Mellon Univ. ...7,200	4. NC Central University.... 4,600
5. U of Houston-Dwntwn.. 5,300	5. Slippery Rock U of P 6,300	5. Wake Technical CC 4,000
TOTAL FTEs 113,100	TOTAL FTEs..... 91,600	TOTAL FTEs..... 75,500

Source: NCES/IPEDS, Enrollment Fall 1997

The prevalence of small institutions has perhaps kept Greater Philadelphia from reaping greater gains in student enrollment. While student enrollment in the region grew by 5,300 students (actual students, not FTEs) between 1990 and 1997, other regions experienced stronger growth in student enrollment (Figure 7), such as the Atlanta MSA, whose student population grew by almost 23,000 students during this period. In the regions with the strongest growth, no doubt university officials accommodated this growth by expanding capacity at their institutions; in some cases, this demand might have been accommodated through the creation of an entirely new university. The strong gains in student population evident in other regions clearly demonstrate that Philadelphia's shortcomings are not necessarily unfilled capacity, but the more fundamental problem of insufficient capacity for a region our size.

Figure 7. Regional Comparison: Percentage Change and Absolute Growth in Students* between 1990 and 1997

Expanded Region	Percentage Change, 90-97	90-97 Difference
New York CMSA	1.31%	12,400
Los Angeles CMSA	8.47%	65,500
Chicago CMSA	4.44%	21,300
San Francisco CMSA	3.66%	16,900
Wash-Balt CMSA	1.08%	4,200
Boston NECMA	1.05%	3,700
Philadelphia CMSA	**1.83%**	**5,300**
Detroit CMSA	-4.69%	(13,400)
Dallas CMSA	-0.52%	(1,100)
San Diego MSA	10.04%	17,700
Seattle CMSA	10.57%	17,100
Houston CMSA	2.83%	4,800
Phoenix MSA	9.21%	14,200
Miami CMSA	15.36%	20,600
Denver CMSA	9.65%	13,200
Minn-St. Paul MSA	2.40%	3,500
Atlanta MSA	20.07%	22,600
Sacramento CMSA	14.76%	15,500
Cleveland CMSA	-15.21%	(21,500)
St. Louis MSA	6.35%	7,000

Source: NCES/IPEDS, Enrollment 1990 and 1997. *Students are actual students, not FTEs. The enrollment status (i.e., full- vs. part-time) is not reported for 1990. Data are reported for the 20 largest regions in terms of actual student enrollment in 1997. Note that this list of regions is not consistent with that reported in figure 3, which is based on FTE enrollment.

Having a knowledge region befitting our size is not just a matter of competing with other large metropolitan areas, but a key requirement for economic success in the new economy. Rich Florida, Carnegie Mellon University professor of regional economic development, explains how regions must leverage the talent of universities in the following statement: "Over time, any university or region must be constantly repopulated with new talent. More so than industrial economies, leading universities and labor markets for knowledge workers are distinguished by high degrees of 'churning.' What matters is the ability to replenish the talent stock. This is particularly true in advanced scientific and technical fields where learned skills (such as engineering degrees) tend to depreciate rather quickly."[23]

Push/Pull Factors

Comparatively Higher Costs

Data on the migration patterns of students is rarely collected at the regional level and only on a limited basis at the state level. Demographic studies to a limited extent have been able to explain why students choose to go to certain locations over others for college. The conclusions of one study reported that non-resident fees charged by institutions and the general economic condition of the state where the student is going were predictive factors for student migration patterns.[24] Comparatively high tuition rates might explain some of the migration patterns of college-bound high school students. For example, in-state tuition at state schools and community colleges is higher in Greater Philadelphia (and Pennsylvania's other major knowledge industry region, Pittsburgh) than in other regions, which might discourage high school graduates from staying in the region (Figure 8). Also, prospective students might be dissuaded by comparatively weak employment growth and a lack of entrepreneurial activity in the region, especially compared to other growing metropolitan areas.

Figure 8. Regional Comparison: Tuition at Select State/State-Related Schools, Community Colleges, and Private Institutions

	State/State-Related (In-State Tuition)	Community Colleges	Private Institutions
Philadelphia CMSA	$6,378 (Temple University)	$2,280 (Montgomery County CC)	$23,254 (Univ. of Penn)
Pittsburgh MSA	$6,424 (Univ. of Pittsburgh)	$2,207 (CC of Allegheny County)	$21,405 (Carnegie Mellon Univ.)
San Francisco Bay Area CMSA	$3,766 (Univ. of CA, Berkeley)	$443 (Foothill College)	$23,058 (Stanford University)
Boston NECMA	$4,269 (Univ. of MA, Boston)	$1,970 (Middlesex CC)	$23,618 (Harvard University)
Raleigh-Durham MSA	$2,262 (UNC, Chapel Hill)	$584 (Durham Technical CC)	$23,144 (Duke University)
Houston CMSA	$2,057 (Univ. of Houston, Univ. Park)	$900 (Houston CC System)	$15,100 (Rice University)

Source: Peterson's, 4-Year Colleges and 2-Year Colleges, Year 2000 Guides

Perceptions of a Regional Brain Drain

One of the most commonly held beliefs about the region's knowledge industry is that if we have any problem, it is that we do not keep enough of our students here – that we have a brain drain. However, no region-wide data has been collected to answer the question of brain drain, even though the issue is commonly assumed to be a problem in Greater Philadelphia.

On a broader scale, demographic studies done on a national basis have identified two predictors that shed light on graduate behavior. The first is referred to as "geographic inertia" – students who are from the region and who stay in the region for school are likely to remain in the region after graduation.[25] On a personal level this conclusion would make sense to most people – strong ties to family, friends and a familiar environment are reason enough for a graduate to stay put. On the other hand, the second predictor is that mobility increases with education – this broader demographic principle clearly has strong implications for college-educated workers, whose employment opportunities after college could take them anywhere.[26]

A survey of select institutions in the region conducted by *Philadelphia Magazine* appears to demonstrate that institutions with the strongest local and regional appeal (Widener, St. Joseph's, Drexel, and Temple) have the largest percentage of alumni still living in the region, while alumni of nationally prominent institutions (Swarthmore, Haverford, Bryn Mawr, Penn) have less of a regional presence (Figure 9). While these figures are not a comprehensive answer to the graduate retention question, they do lend credibility to the idea of geographic inertia – students who attend institutions of regional and local appeal (and therefore are most likely from the region) are more likely to stay in the region after graduation.

Figure 9. Alumni Presence in Five-County Philadelphia Region

	Total Alumni Population	Alumni in 5-County Phila. Region*	% of Alumni in Region
Widener University	24,000	16,000	67%
St. Joseph's University	37,000	23,000	62%
Drexel University	65,000	35,400	54%
Temple University	200,839	93,863	47%
Villanova University	77,000	33,000	43%
University of Pennsylvania	228,000	63,512	28%
Bryn Mawr College	20,000	4,000	20%
Haverford College	10,603	1,423	13%
Swarthmore College	17,400	1,423	13%

Source: Philadelphia Magazine, 1997, Widener University. *The Pennsylvania counties of Bucks, Chester, Delaware, Montgomery, and Philadelphia.

If the idea of geographic inertia applies in Greater Philadelphia, then the graduate retention debate largely boils down to concerns surrounding the region's appeal to graduates from nationally prominent schools. This concern tends to be voiced strongest around graduation time, when surveys of students regarding their post-graduation plans are featured in regional newspapers. The post-graduation plans of graduates from the University of Pennsylvania's Wharton School are particularly prominent – last year, for instance, a widely publicized survey reported that a smaller share of students graduating from the MBA program stayed in the region after graduation than what other regions retained from their MBA programs.[27]

In light of the host of external factors that drive individuals' location decisions, the region should not dwell too much on worries of student retention or brain drain. In any region, students who are among the nation's best and brightest are perhaps the most difficult to retain – demand for them is high, making their employment prospects strongest and their mobility greatest. Furthermore, many of them are not originally from the region and therefore they have fewer ties to the area. More importantly, the region ranks low in measures of enrollment concentration, even in comparison to other large metropolitan areas and new economy hot spots such as Boston, San Francisco, San Diego, Denver and Phoenix, not to mention smaller, but explosively growing metro areas such as Raleigh-Durham and Austin, TX. These concentration measures suggest that our resources might be better spent on student attraction in order to increase the base of our student population. (On the other hand, graduate retention might be more of concern for a region such as the Pittsburgh MSA, which does well in concentration measures but suffers from the same flight of young people as the Philadelphia region does.)

Becoming a More Knowledge Worker-Friendly Place

While the quality of our institutions is an important factor in drawing people to a college or university in the area (whether they are students, professors, or researchers), the region itself and the communities it consists of must be attractive and desirable places where people can live. If Philadelphia is to become known as a knowledge region, it must expand its pool of knowledge workers. It is not coincidental that those large regions with high student concentrations – the San Francisco's, Boston's, San Diego's, Austin's and Raleigh-Durham's of the world – are also nationally and internationally recognized as centers of the new economy. Companies in these regions have more assurance that they can find the knowledge workers – at all educational levels – that they need to grow and thrive. The region must be prepared to address the issue from a number of fronts – expanding programs at existing institutions, exploring the possibilities of building new institutions or programs, forthrightly addressing the cost issue, and focusing on lifestyle factors that might keep more of our students in the region after graduation.

The appeal of the Philadelphia region becomes all the more important as we build and stake our claim as a premier knowledge industry location. The more knowledge workers we are able to attract to the region, the larger a pool of workers we are able to offer regional employers, especially new economy companies. The importance of appealing to knowledge workers is underscored by the following observation: "Ironically, while…entrepreneurs can ultimately deliver their products from anywhere, these firms may be even more constrained in their locational choices."[28] Simply stated, a region that is able to draw in knowledge workers because of its lifestyle appeal has a major competitive advantage over others. What quality of life is appealing to knowledge workers? Carnegie Mellon Professor Rich Florida has done extensive focus group work with young knowledge workers in attempt to understand what characteristics of communities and regions are appealing to this group.[29] He has made the following conclusions about young knowledge workers:

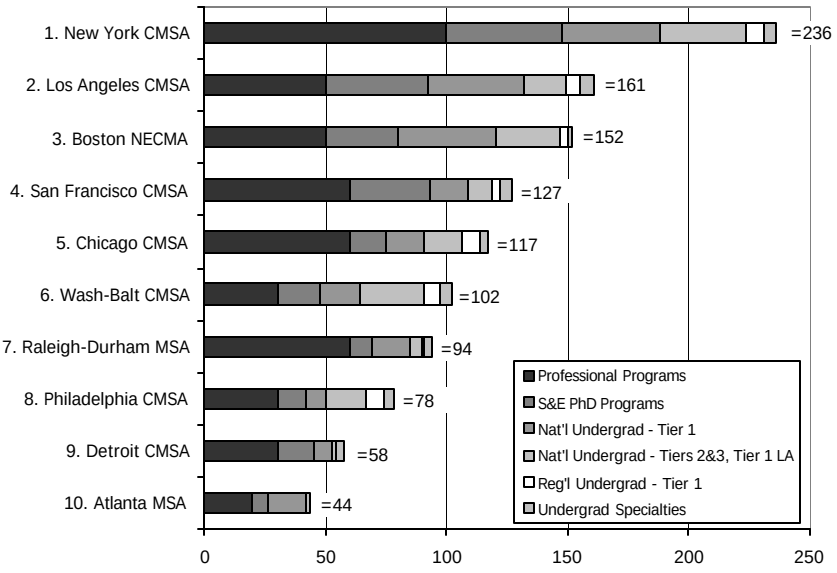
- **Youth-oriented amenities**: These college-educated workers are looking for meaningful, high-quality experiences and environments for using their time outside of their work. These include a population of visibly active young people, a vibrant music and performance scene, and easy access to and opportunity to participate in a wide range of outdoor activities.
- **Diversity**: Young knowledge workers also want to experience a range of activities and have a mixture of experiences. They prefer activities that are "…more casual, open, inclusive, and participative…" Just as knowledge workers seek "thick labor markets" in order to accommodate their tendency for high turnover, so too are they looking for the ability to hop around in their leisure time.
- **Accessibility and Connectivity**: Given the long hours that many are required to work, knowledge workers want to have access to amenities on a "just-in-time" basis. They are not necessarily looking to become part of an activity or group for a long period of time, and they want to be able to explore the city and region, and not always by car.

While Professor Florida was focusing in on knowledge workers, the same observations could be made about college students. The college experience serves as a two or four-year test drive of the region as a place in which to live, work and play. The more we can do to make that experience one which helps both students and knowledge workers make the decision to locate here, the better the region can compete as a knowledge region. The list of those regions with the highest concentration of students is instructive. Each region – Austin, San Diego, Boston, San Francisco, and Denver – enjoys a reputation as a place that values young people and provides a variety and diversity of outdoor and social experiences. Not coincidentally, each region also ranks highly as a center of the New Economy.

Quality: Gaining a Reputation as a Leading Knowledge Region

In an index of higher education quality, the region ranks 8th in the quality of institutions and academic programs as ranked by *U.S. News and World Report* in 2000(Figure 10).[30] While the rankings awarded to many of Greater Philadelphia's institutions by *U.S. News & World Report* earn the region a place on the nation's knowledge industry map, competition with other regions' knowledge industries is stiff. Indeed, the stiffest competition appears to be among the top-ranking regions. In particular, Raleigh-Durham, whose student population ranks 23rd in terms of the number of full-time equivalent students, stands out as the 7th most recognized region by the *US New* rankings. This index might be a blunt measure of education quality, but the perception being put forth by major publications such as *U.S. News* is that Greater Philadelphia's collective reputation is good, but not the best.

Figure 10. Regional Comparison: Rankings in Higher Education Quality Index



Source: PEL calculations based on U.S. News & World Report, 2001 Rankings for Graduate Programs for Colleges. Refer to Appendix C: Notes on Methodology for an explanation of the methodology used to calculate the higher education quality index.

The common element of the seven top-ranking regions (with the exception of the Washington-Baltimore CMSA) is the presence of:

- at least one institution (if not two) that is nationally recognized at the undergraduate level and for all three major areas of graduate study (law, medicine, and business); and
- at least one other institution that is nationally recognized at the undergraduate level and for at least one of the three major areas of graduate study.

For the New York metro area, these institutions are Columbia University, New York University, Princeton University, and Yale University; for Boston, they are Harvard University and MIT; for Los Angeles, they are UCLA and USC; and for Raleigh-Durham, they are UNC-Chapel Hill and Duke University. Most of these regions also have at least as many nationally recognized 2nd-tier institutions and liberal arts colleges that round out their reputations as major centers for knowledge workers.

After this group of regions begins another group that is nationally recognized at the graduate and undergraduate level, though this recognition is usually the distinction of only one institution in the region or is the combination of lower rankings of several less prominent institutions. This group includes the Philadelphia region, where the University of Pennsylvania stands out as the only institution that is nationally recognized for overall undergraduate education as well as the three major areas of graduate studies in law, medicine, and business. No other institution in the region shares this distinction. The only other institutions that make a showing in the rankings were placed in the 2nd or 3rd tiers of the *U.S. News* rankings or the 1st tier of Northern Regional institutions, or were recognized as high-caliber liberal arts colleges (which have small student bodies). The Washington-Baltimore CMSA, with two institutions (Georgetown University and Johns Hopkins University) receiving high praise at the undergraduate level but lesser recognition at the graduate level, also appears to fit in this group.

Another way to look at the national recognition that our institutions and programs receive is through the number of faculty awards received and memberships to the National Academy of Sciences (NAS). The ability to attract and retain star faculty, particularly in the sciences, can be a key factor in the future attraction of star students, faculty, and even venture capital and company interest. For both these forms of scholarly recognition, the Philadelphia region significantly lags the national leaders, while maintaining a position in the top of a second tier of regions. For example, when summing the number of NAS members, who are recognized by their peers as distinguished scholars and the leaders in their fields, Philadelphia ranks 7th in the total number of members, but has only about one-fifth the members claimed by institutions in both the Boston and San Francisco Bay regions. Likewise, when major faculty

awards are totaled by region, Philadelphia institutions lag the national leaders in 8th place, accumulating only about 35 percent of the number of awards gathered by faculty at institutions in Boston and the San Francisco Bay Area (see Figure 11).

Figure 11: National Academy of Sciences Members and Faculty Awards*, by Region, 1999

	NAS Members		Faculty Awards
1. Boston NECMA	507	1. New York CMSA	239
2. San Francisco CMSA	488	2. San Francisco CMSA	173
3. New York CMSA	364	3. Boston NECMA	152
4. Los Angeles CMSA	217	4. Los Angeles CMSA	107
5. Wash-Balt CMSA	103	5. Chicago CMSA	86
6. Chicago CMSA	97	6. Wash-Balt CMSA	84
7. Philadelphia CMSA	**93**	7. Raleigh-Durham MSA	70
8. Raleigh-Durham MSA	91	**8. Philadelphia CMSA**	**60**
9. San Diego MSA	85	9. Detroit CMSA	56
10. Seattle CMSA	70	10. Seattle CMSA	42

Source: PEL calculations based on data reported by the University of Florida, TheCenter (The Lombardi Program on Measuring University Performance), The Top American Research Universities, July 2000. *Refer to Appendix C: Notes on Methodology for the list of faculty awards that make up this measure.

Generating Innovation: Translating Faculty Research into Ideas and Companies

With nearly $666 million in R&D spending the region ranks 7th nationally in the amount of R&D funding at regional research institutions (Figure 12). However, there is a large gap between Greater Philadelphia and those it trails. It would take over $100 million dollars to catch number 6 (Raleigh-Durham), $490 million to overtake number 5 (Los Angeles), and over half a billion dollars to pass number 4 (Boston). Greater Philadelphia also lags behind other regions in the intensity of institutional research spending. In Greater Philadelphia, institutions spend $111/1,000 residents compared to Raleigh-Durham, where regional institutions spend $716/1,000 residents; Boston, where institutions spend $207/1,000 residents; and San-Francisco-Oakland-San Jose, where institutions spend $189/1,000 residents. As with the *U.S. News* rankings, the region's research capacity rests largely on the shoulders of the University of Pennsylvania, whose spending accounts for 50 percent of overall regional R&D expenditures. In the leading regions, however, research activities are often driven by several institutions of Penn's size and quality (most of which were placed at the top by the *U.S. News* rankings).

While our region's research universities offer a strong capacity for generating new knowledge and ideas, other regions are also focusing on this key element. According to data issued by the National Science Foundation (NSF), even though regional R&D expenditures expanded by 66 percent between 1991 and 1998, most other regions' R&D expenditures grew during this period as well. Just as competition has stiffened for top-ranking positions in teaching, institutions are competing more fiercely for increases in federal funding of university-based research. Furthermore, while the region ranks 7th, the remaining regions in the top 10 are not far behind in total R&D expenditures – conceivably, any slippage on the part of the Philadelphia region or significant gains made by other regions could take Philadelphia out of the top 10.

Figure 12. Regional Comparison: Total R&D Expenditures (Millions of Dollars), Growth (1991-1998)

	R&D Expend. (millions)	Growth, 1991-1998
1. New York CMSA	$1,759	39%
2. Washington-Baltimore CMSA	$1,583	31%
3. San Francisco Bay Area CMSA	$1,291	46%
4. Boston NECMA	$1,216	54%
5. Los Angeles CMSA	$1,156	66%
6. Raleigh-Durham MSA	$773	72%
7. Philadelphia CMSA	**$666**	**66%**
8. Chicago CMSA	$654	54%
9. Detroit CMSA	$645	46%
10. Houston CMSA	$644	42%
11. Atlanta MSA	$525	73%
12. San Diego MSA	$462	59%
13. Madison MSA	$444	36%
14. Seattle CMSA	$432	58%
15. Bryan-College Station MSA	$394	37%
16. Minneapolis-St. Paul MSA	$363	9%
17. State College (PA) MSA	$363	35%
18. Pittsburgh MSA	$353	51%
19. Denver CMSA	$343	91%
20. Champaign-Urbana MSA	$339	39%

Source: PEL calculations based on data from the National Science Foundation (NSF), FY1998

Greater Philadelphia lags even further behind other regions in terms of R&D expenditures per capita (i.e., per 1,000 regional residents), ranking 17th among the same group of 20 regions with the largest R&D expenditures in the country (Figure 13). This ranking shows the strength of major research institutions (many of them public) in small metropolitan areas such as College Station, TX, State College, PA, and Madison, WI, which top the rankings. Nevertheless, several large metropolitan areas rank higher than the Philadelphia region in per capita expenditures, such as the Washington-Baltimore, Boston, and San Francisco regions.

Figure 13. Regional Comparison: R&D Expenditures Per 1,000 Residents

	R&D Per Capita
1. Bryan-College Station MSA	$2,960
2. State College (PA) MSA	$2,727
3. Champaign-Urbana MSA	$2,017
4. Madison MSA	$1,044
5. Raleigh-Durham MSA	$716
6. Washington-Baltimore CMSA	$217
7. Boston NECMA	$207
8. San Francisco Bay Area CMSA	$189
9. San Diego MSA	$166
10. Pittsburgh MSA	$150
11. Houston CMSA	$146
12. Denver CMSA	$145
13. Atlanta MSA	$140
14. Minneapolis-St. Paul MSA	$128
15. Seattle CMSA	$126
16. Detroit CMSA	$118
17. Philadelphia CMSA	**$111**
18. New York CMSA	$88
19. Chicago CMSA	$74
20. Los Angeles CMSA	$73

Source: PEL calculations based on data from the NSF, FY1998

Lack of Diversified Excellence in the Sciences

While the life sciences (biological and medical sciences) are research strengths of the region, they appear to be dominant in many other regions as well. Indeed, what characterizes Greater Philadelphia is a *comparatively* weaker research capacity in engineering and physical sciences, as indicated by R&D expenditures and the number of graduate programs placed in the top 25 of their field by *U.S. News & World Report* (Figure 14). The metro areas of Boston, Silicon Valley, and Raleigh-Durham stand out as having strong capacities in other major research fields of science and engineering (in addition to life and biological sciences).

Figure 14. Regional Comparison: Total R&D Expenditures (millions) and Select Research Programs Ranked in Top 25 for Major Science & Engineering Fields*

	Life Sciences		Engineering		Phys./Computer Sciences	
	R&D Expend.	Top-25 Programs	R&D Expend.	Top-25 Programs	R&D Expend.	Top-25 Programs
San Fran. Bay Area CMSA	$750	33	$216	24	$222	58
Houston CMSA	$539	7	$19	3	$43	4
Raleigh-Durham MSA	$526	22	$94	7	$101	9
Boston NECMA	$498	23	$205	16	$249	53
Philadelphia CMSA	$495	12	$49	4	$58	6
Pittsburgh MSA	$196	3	$34	8	$84	8

Source: NSF, FY1998; U.S. News & World Report, 2001. *Life sciences consists of agricultural, medical (including veterinary), biological sciences; engineering consists of aeronautical/astronautical, bio(medical), chemical, civil, electrical, mechanical, and metallurgical engineering; and physical/sciences consists of astronomy, chemistry, physics, environmental science, mathematical sciences, and computer sciences. Top-25 rankings are for overall programs and specialties for each field. Note: This table is not a comprehensive ranking of regions.

The difference between regions lies in the number of institutions that contribute to the overall regional research capacity. Unlike Greater Philadelphia, whose research capacity is largely tied to one institution, the University of Pennsylvania, each of the above-mentioned regions has *several* institutions of equal strength and caliber as Penn –

Boston has Harvard University, MIT, and Boston University; Raleigh-Durham has Duke University, UNC Chapel Hill, and NC State University; and, San Francisco-San Jose-Oakland has Stanford University, UC Berkeley, and UC San Francisco. The combined research intensity of these regions is reflected in a more diversified base of institutional research strengths.

Furthermore, much of the Philadelphia region's research capacity is tied to one major field of study that is targeted by several institutions of similar nature. The vast majority of our region's research is conducted in the life sciences, particularly the applied world of the medical sciences. Considering the fact that four of our top five research institutions are or include academic health centers (Thomas Jefferson University, MCP Hahnemann University, the Hospital of the University of Pennsylvania, and the Health Sciences Center of Temple University) this preponderance of medical science research in not surprising. In fact, the similarity between research institutions suggests that they might be competing intensely for research dollars, rather than looking for areas of collaboration and cross-fertilization between a more diverse set of disciplines.

Well-Established Competitor Capacity

The Philadelphia region faces stiff competition in the race to commercialize university research findings. A regional comparison of technology transfer activities demonstrates Greater Philadelphia's comparatively young but growing tech transfer capacity (Figure 15). Boston leads the nation in inventions disclosures received, patents issued, and licenses executed. The strong showing of some other regions is partly attributable to the long length of time in which they have been engaged in technology transfer. Boston's institutional technology transfer programs have an average age of 17 years and San Francisco's have an average age of 24 years, while Greater Philadelphia's institutions are only 11 years old on average. All programs in the region were started after the Bayh-Dole Act; the University of Pennsylvania, which established its program in 1986, was the last of the Ivy League universities to set up an office of technology transfer.

Figure 15. Regional Comparison: Top 10 Regions for Fiscal Year 1998 Technology Transfer Activities

Invention Disclosures Received	Patents Issued	Licenses & Options Executed
1. Boston NECMA 995	1. Boston NECMA.....405	1. New York CMSA.....293
2. Los Angeles CMSA..... 673	2. San Francisco CMSA ...200	2. Boston NECMA 282
3. New York CMSA 632	3. New York CMSA.....190	3. San Francisco CMSA ...187
4. San Francisco CMSA... 494	4. Los Angeles CMSA.....157	4. Wash.-Balt. CMSA 173
5. Phila. CMSA 443	**5. Phila. CMSA 131**	5. Los Angeles CMSA.....170
6. Wash.-Balt. CMSA..... 414	6. Wash.-Balt. CMSA 109	6. Raleigh-Durham MSA..154
7. Chicago CMSA 328	7. Raleigh-Durham MSA..104	**7. Phila. CMSA..... 141**
8. Raleigh-Durham MSA . 319	8. Chicago CMSA 83	8. Seattle CMSA.....128
9. Seattle CMSA..... 282	9. Madison MSA..... 78	9. Athens (GA) MSA 94
10. Houston CMSA..... 212	10. Detroit CMSA..... 71	10. Madison MSA 75

Source: Association of University Technology Managers (AUTM), FY1998 Licensing Survey

Critical Mass: Building Centers of Business and Research Excellence

Most regions that are nationally recognized for their leadership in knowledge industries have developed – either through market forces or a specific economic development strategy – nationally recognized centers of business *and* research activity. Whether it is the city of Cambridge in Massachusetts, the Research Triangle Park in Raleigh-Durham, NC, or the Stanford Research Park in Palo Alto, the close relationship between academic leadership and business leadership are readily apparent to both residents of the region and the nation. And the leading regions are not resting. And the leaders are not stopping. In San Francisco, the proposed Mission Bay mixed use development project has the potential of creating an entirely new community around the biotech research strengths of the University of California-San Francisco. Likewise, in Raleigh, North Carolina State University is developing its Centennial Research Campus to serve as an urban alternative to the sprawling Research Triangle Park.

Another new development has been the creation of virtual research centers, centered on a concept or specific field. In Pittsburgh and the State of Georgia, business, government and university leaders, working with the Cadence Corporation, have created prototype consortiums focused on making their regions the leaders in cutting-edge technologies. Pittsburgh's Digital Greenhouse is combining the resources of Carnegie-Mellon University, the University of Pittsburgh and Penn State University with local and national technology firms in an effort to make the

region the leader in the development of system-on-a-chip technology, and Georgia's Yammacraw Alliance is undertaking a similar effort. These efforts can be termed virtual, because unlike other research parks, their focus is not on real estate but on ideas and research. By letting the market dictate real estate priorities, these efforts can focus on developing new markets and technologies, rather than filling buildings.

Despite the best efforts of the leadership of the University City Science Center (the nation's first urban research park), the connections between business and academy in Greater Philadelphia have been less successful. However, with the Science Center's efforts to reposition its new and existing real estate products and the ongoing economic development efforts of the University of Pennsylvania, there is an opportunity to identify University City as the research center of the mid-Atlantic region, akin to Cambridge's role as the center of New England's innovation economy. Staking out such a leadership position would benefit the entire region, as the ideas, concepts and companies spun out of University City would help position Greater Philadelphia as a leading region for technology-oriented business.

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[9] In the Milken report, Greater Philadelphia is defined by the 9-county Philadelphia, PA-NJ PMSA.
[10] Cognetics, 1999.
[11] Refer to Appendix C: Notes on Methodology for an explanation of PEL's estimates of population educational attainment figures, which are based on 1990 Census data.
[12] Greater Philadelphia First (GPF), Regional Economic Benchmarks, July 1999. GPF measures income opportunity using the Income Opportunity Index, which it describes as "...a composite measure that standardizes cross-regional comparisons of prosperity. The index multiplies the proportion of the region's working-age population that is employed times the region's average annual wage and adjusts the result to reflect the region" relative cost of living" (p. 14).
[13] The Regional Workforce Partnership, Workforce 2000: An Annual Report on Greater Philadelphia's Workforce, May 2000.
[14] Florida, Summer 1999.
[15] Florida, Summer 1999.
[16] Cognetics, 1999, p. 2.
[17] Throughout the report, the metro regions used for comparison are the largest metropolitan designations for each region. Refer to Appendix A: Regional Rankings for a more complete listing of the official metro areas discussed in the report.
[18] Refer to Appendix C: Notes on Methodology for an explanation of the methodology used to calculate the net gain/loss in college-bound young people.
[19] The City of Philadelphia disputes the Census Bureau's 1990 population count, claiming an undercount of at least 60,000. When the City's estimate is used to calculate population losses between 1990 and 1997, the average annual net loss is about 12,900.
[20] NCES study of 1992 fall enrollment of college freshmen.
[21] NCES/IPEDS, Enrollment Fall 1990 and 1997. The overall student population grew by 1.8 percent between 1990 and 1997.
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[30] Refer to Appendix C: Notes on Methodology for an explanation of the methodology used to calculate the higher education quality index.

KNOWLEDGE REGION COMPETITION

Around the country, regions are focusing on how they can best utilize their higher education assets as focal points of economic development strategies. In this section, we describe how a number of Greater Philadelphia's competitor regions are approaching the challenge of harnessing colleges and universities strengths into a competitive advantage in the New Economy.

Metropolitan areas with technology-based research institutions have a distinctive advantage in the new economy. Not only do these facilities help produce technology-based industries, they also raise a region's standard of living through high employment and wage growth. Whether it is a research university, federal laboratory, or corporate R&D unit, these entities attract the students, researchers, and scholars who will power the next generation of ideas and companies. As a result, metropolitan regions are implementing strategic campaigns to support their research infrastructure and attract high-tech firms from outside the region.

Additionally, state governments and regional organizations are examining their higher education assets for opportunities to build upon historic strengths and turn them into new sources of economic activity. Over the past decade there has been a flurry of new initiatives in the form of:

- Research alliances, bringing academic and business interests together to increase regional/state research funding and academic quality;
- Industry consortia to capitalize on specific knowledge industry regional strengths;
- New institutional capacity or programs to fill gaps or holes in a region's workforce;
- New communities around colleges and universities centered on research and business synergies in the knowledge economy.

This section profiles how rival metropolitan areas are approaching the challenge of becoming knowledge regions. First, we examine impressions and lessons drawn from benchmarking visits to the Boston, Baltimore, and San Francisco Bay Area regions. Then we focus on efforts underway in Pittsburgh, the Research Triangle, Atlanta and San Diego. These comparisons are presented as evidence that the rest of the world is not standing still. Regions from both ends of the spectrum – acknowledged leaders like Boston, San Francisco and Raleigh Durham and those aspiring to leadership but not there yet like Atlanta, San Diego and Pittsburgh – are aggressively pursuing strategies to build their knowledge industry capacity and quality in order to meet their region's economic challenges.

Obviously, there is no one formula for success, nor will a solution come quickly or easily. However, it is clear that Greater Philadelphia must develop a strategy if it wants to be a leader in the knowledge economy. The question is whether the region is will and able to take advantage of its strengths while facing it's internal and external challenges.

Three Different Regional Approaches

Baltimore, Maryland

Baltimore is a city that shares many of the characteristics as Philadelphia. As a city with an industrial past, Baltimore is attempting to transition from a manufacturing to a knowledge economy. The city and region possesses tremendous research assets such as the University of Maryland and Johns Hopkins University and is blessed with cultural resources not found in other metropolitan areas. However, the city has been severely affected by the rapid changes brought on by new economic realities. The decline in manufacturing resulting in the loss of jobs and businesses; an exodus of middle class citizens to the suburbs and elsewhere; an increasing concentration of poverty; and a decaying housing stock have made the city a less desirable place to work, live and do business.

With approximately 25,000 full-time and part-time employees, Johns Hopkins University is a crucial asset for the region's economic competitiveness. Johns Hopkins has earned a worldwide reputation as a place for cutting-edge medical teaching and biomedical research. As a result, the institution has received a significant amount of federal funding for scientific and medical investigations. According to data from the National Science Foundation, the Washington-Baltimore region ranked first in the nation in total R&D expenditures in fiscal year 1998 with $1.55 billion, of which Johns Hopkins University accounted for $854 million or 55 percent of the metropolitan area's total. Johns Hopkins also accounted for over half of all patents issued as well as licenses and options executed. The university's medical school, teaching hospitals and health system have attracted highly acclaimed facility and talented students from around the world.

The university's ability to earn federal research grants is due partly to its proximity to the National Institutes of Health's main campus in Bethesda, Maryland. Such closeness has helped in creating a relationship between the two institutions that extends beyond research grants and contracts. The two institutions have collaborated on research projects and NIH has extended its presence by establishing two research centers on John Hopkins' Bayview campus.

Greater Baltimore is also assisted by a renewed effort on the part of Maryland's state government to support R&D efforts within the University of Maryland System. In 1996 the state legislature passed a public-private partnership statute that allows faculty members at state universities to be paid consultants to, or shareholders or officers of, corporations that profit from their inventions or discoveries. The legislation has helped faculty at The University of Maryland Medical System, which includes the Medical Center at Baltimore, in creating new high technology and biotechnology companies instead of licensing their research to corporations. Likewise, state funding has helped to develop the University of Maryland-Baltimore County into a well-regarded research university and to expand its capabilities with the construction of a 41-acre research park next to its campus (a former Lockheed Martin corporate campus).

Major Projects/Initiatives

Johns Hopkins Bayview Campus – The Johns Hopkins Bayview Campus is one of three Hopkins sites in Baltimore (the medical school's East Baltimore campus and the main campus at Homewood are the other two locations). Formerly the site of Baltimore City Hospital, the 130-acre development includes several structures that house university, federal, and commercial medical research and patient care. Johns Hopkins Bayview Medical Center and its Asthma and Allergy Center are located on campus as well as federal programs such as the National Institutes of Health (NIH) Gerontology Research Center and the NIH/NIDA (National Institute on Drug Abuse) Addiction Research Center. Additionally, the campus provides laboratory and office space for commercial enterprises along with a 25,000-square-foot biotech "incubator" called Alpha Center for early-stage biotechnology firms. At present, Bayview has over 2 million square feet of office and lab space, with another 3.4 million square feet to be completed as part of the campus' master plan. One of the advantages John Hopkins uses to sell the campus to potential tenants is its proximity to two interstates (I-95 and I-895) and the Baltimore-Washington International (BWI) Airport. The campus also provides more than 5,000 jobs to the city and the region.

Even with these resources for medical and biotechnology innovation, Bayview has been more successful in generating sponsored research than incubating new biotechnology companies. Many Hopkins scientists view Bayview's suburban-like location as isolated from the medical school and downtown Baltimore. Additionally, a stable working class/middle class residential community surrounds the campus so there are no opportunities for the campus to expand beyond its current boundaries. This limits the ability to create buildings for biotech startups within walking distance of the campus as well as thwart the establishment of late-night restaurants and retail shops that are conducive to the untraditional hours of employees at these firms. Furthermore, Bayview is hampered by the lack of communication between Johns Hopkins' technology licensing office and the campus' principal investigators.

Lessons

Research campus must be connected to the surrounding neighborhood – Bayview Research Campus has little opportunity to expand outside its current boundaries. Few restaurants, bars and retail stores are present in the surrounding community.

Attracting federal funding matters – Johns Hopkins ability to attract federal dollars provide credibility to the projects it undertakes and prestige for attracting top investigators and students. The university's location to NIH provides opportunities for collaboration that can foster stronger relationships between the two institutions.

State involvement can be helpful – The creation of UMBC's research park and the Maryland State Legislature's public-private partner statute are just two ways Maryland is underpinning the resources of its research universities. Strategic support for core research infrastructure can make it easier for faculty and students to start and grow biotech and information technology firms within the state.

Boston/Cambridge, Massachusetts

The Boston/Cambridge area represents the type of entrepreneurial environment one could envision for the Philadelphia region and University City. Harvard, MIT, Boston University, and other universities are doing a tremendous job of attracting college-age adults to the region and retaining them once they graduate. Even more important, the universities, particularly Harvard and MIT, have been critical to the region's – and the nation's – job creation impact. For example, a 1997 BankBoston study reported that MIT students, graduates and faculty created 4,000 companies employing 1.1 million people and having annual world sales of $232 billion. If the companies founded by MIT graduates and faculty formed an independent nation, the revenues produced by these companies would make that nation the 24th largest economy in the world. Within Massachusetts alone there are over 1,000 MIT-related firms employing 353,000 people worldwide and 125,000 people in the state.

Equally, in a recent economic impact study conducted for Harvard University, Harvard alumni headed 22 of the hundred fastest growing publicly owned companies in the metropolitan area in 1998. Additionally, of the twenty-five largest venture capital firms in the Boston area, Harvard graduates headed twelve (including four of the top five).

Why is the Boston area such an ideal environment for new business creation? First, the types of firms MIT, Harvard, and other research university students and faculty create are highly dependent on a workforce of skilled professionals. Biotechnology, software, electronics, and communications all require people who are exposed to cutting edge technologies and new ideas. Additionally, the universities themselves provide opportunities for students and faculty to test the water in establishing their own businesses.

Private and university endeavors are driving many of the region's entrepreneurial initiatives, with little involvement from local and state government. Where government is playing a role is in reducing business regulation. The governor and the state legislature have worked in recent years to improve the state's business climate. The abundant amount of entrepreneurial activity has created a shortage of office and lab space in the region, particularly Cambridge, where proximity to both Harvard and MIT is considered a premium. Local developers, aware of the sensitivity by local citizens to any new construction, have responded by become leading proponents for mixed-use research buildings.

Best Practices

University Park at MIT – University Park is an attempt by MIT to revitalize an underutilized section of Cambridge, while investing in the long-term development of the campus. The 27-acre development was designed to provide excellent mixed-use office park facilities that could be easily converted to the needs of both biotechnology and information technology firms. Forest City Commercial Group, the developers and property managers for the park, worked with MIT and the local community to execute a plan that was adaptable to the changing needs of the area. University Park's amenities include a 210-room hotel, a 53,000 square-foot supermarket, over 75,000 square feet of retail space and 142 residential units. The park currently has six research buildings, primarily consisting of biotechnology and biomedicine firms, with a combined square footage of more than 800,000 square feet. Forest City has secured commitments on four additional research and office buildings totaling 675,000 square feet, plus construction has begun on 361 new units of housing.

University Park's construction has been attractive for local biotechnology and information technology firms desperate for space. So far, top-tier pharmaceutical firms such as Millennium Pharmaceuticals and Cereon Genomics have established significant operations in University Park partly because of the quality of the buildings and the proximity to MIT.

Entrepreneurship at MIT – Dozens of ideas that have develop into successful companies come from MIT's talented students. The university provides a supportive environment for young adults to discover whether their business ideas are good enough to receive funding. For example, students from MIT's Sloan School of Management run a highly successful business plan competition that creates a flurry of entrepreneurial activity on campus and in the Boston area. Now in its eleventh year (compared to the Wharton School's second), the 50K Entrepreneurship Competition

has become so successful that MIT is now organizing conferences in Europe and Asia to show university officials how to create their own student business plan competitions.

Harvard University's Community Efforts – One reason for Harvard's contribution to the region's human capital and business leadership is the active involvement of its students and faculty in the local community. Harvard publishes a directory of university-related community service programs in Boston and Cambridge to demonstrate the university's commitment to its host cities. Under the leadership of Paul Grogan, Vice President of Community and Public Affairs, Harvard is fostering better community ties within four areas: Health, Schools and Children, Public Leadership (the creation of professional development institute for local officials as well as customized programs), and Economic Impact. For example, Harvard is partnering with the City of Boston and existing Cambridge community development corporations (CDC's) on affordable housing initiatives. The goal of Harvard's outreach is to demonstrate to city government officials that universities are important economic assets for the region's economy.

Boston University Medical Center's BioSquare – Boston University Medical Center's $350 million research park is the centerpiece of the university's strategy to develop innovation in science and business. Two buildings totaling 392,000 square feet have been completed so far – the Center for Advanced Biomedical Research and Evans Biomedical Research Center – with three additional research and office structures and a parking garage planned for the near future. Unlike University Park, BioSquare is designed as a full-scale incubator facility for young companies. Boston University provides Technology Development Grants (20-30K awards from BU's budget); the use of the university's core facilities; incubator space; business expertise, business plan writing; legal assistance; and seed capital (from BU's Community Venture Fund). This a major gamble on BU's part, but university administrators believe the institution has to move boldly if it wants to be a leading biotechnology center. Already, BU's academic resources in one area, photonics, are paying off in the formation of new companies.

Lessons

Critical mass can create an identity for a region – The success of MIT and Harvard, combined with active private business activity, have made Cambridge the centerpiece of New England's knowledge economy. The combination of academic and private research activity reflects well upon the entire Boston metropolitan region, and helps to elevate the entire region's knowledge industry.

Mixed use is a priority – As University Park at MIT demonstrates, the confluence of office, lab, retail and restaurant space provides opportunities for workers and citizens to interact in unexpected ways. For one, a mixed-use lab integrates the research buildings with the neighborhood and provides more goods and services to local citizens. Additionally, since workers often reside in the local area, restaurants and retail establishments can tailor their services to the untraditional hours of workers, thus creating a 24-hour community.

Make students feel connected to a larger community – MIT's 50K Entrepreneurship Competition and Entrepreneurship Lab provide opportunities for students to learn more about the city and region. Whether working on a business plan or networking with regional venture capitalists, students gain a better appreciation of the region's resources, which may entice some to stay after graduation to work for or start a new company.

San Francisco Bay Area, California

The San Francisco Bay Area has become the world's leading technology region, built upon a network of research universities, federal research laboratories, and corporate R&D facilities, which draw top scientists and researchers from around the world in a wide array of disciplines. The region not only has the largest concentration of technology-oriented firms in the world, the economy also includes a broad distribution of computer and electronics, bioscience, telecommunications, and multimedia firms.

The region's success and the entrepreneurial culture driving it are due in large part to the foresight of one man: Stanford's Dean of Engineering Fredrick Terman. A professor of electrical engineering at Stanford and the man who encouraged William Hewlett and David Packard to start a company in the late 1930s, Terman was concerned with the lack of opportunities for Stanford engineering graduates in the Bay Area. He was discouraged that his graduates had to move to the east coast to find work because there were so few jobs available locally.

Terman is credited with laying much of the groundwork for Silicon Valley. While the head of a defense research project team at Harvard University during the early 1940s, Terman believed the federal government would invest heavily in electronic research after the war. Upon his return to Stanford in 1946 as Dean of Engineering, Terman used his government experience and contacts to secure federal funding for research. He encouraged faculty members

to become acquainted with engineers in industry to learn about new opportunities. Terman served on the board of directors for a number of young companies, and was a frequent speaker at industry meetings. He also encouraged local industrial scientists to learn what the university was doing, and how its research might help their business.

Along with individual leadership, there has been a long-term investment by the State of California in higher education and management of national laboratories for the U.S. Department of Energy. As California's population increased, university officials and state leaders have had the foresight of not concentrating the university's entire research base at one campus. Additionally, making the University of California, California State, and Community College system affordable has allowed millions of students to earn degrees and enter the state's workforce.

Today, the cross-fertilization between the research universities and industry allows for the experimentation and collaboration that produce new discoveries and information. Further, researchers with an entrepreneurial bent move between the laboratory and the boardroom to translate new discoveries into marketable products. Today, the region has become a hotbed for entrepreneurial activity in biosciences and placed-based strategies that have helped to create new urban neighborhoods in the cities of San Francisco and San Jose.

Best Practices

UCSF Mission Bay – The University of California at San Francisco's (UCSF) interest in relocating outside San Francisco in the mid-1990s forced local government to draft a development strategy to keep the university in the city. Mayor Willie Brown approached the CEO of Catellus Development Corporation about the idea of using some of the company's land to build a new research campus for UCSF. Catellus, which owned 303 acres of underutilized warehouse land in the city's Mission Bay section, was interested in building a major development that would attract technology companies and revitalize the area. Through a series of negotiations, Catellus donated 43 acres of land to UCSF so that the university could build a new campus.

The research park is currently under construction and will consist of 20 buildings with a combined area of 2.65 million square feet. Mission Bay will employ up to 9,000 researchers and housing three new interdisciplinary programs. More than $1 billion in local, state, and private funds will be invested in the project, of which $390 million will be used to finish the first phase alone. The City, particularly San Francisco's Redevelopment Agency, worked with Catellus to remove regulatory barriers for private developers who adhere to the principles of Catellus' master plan guidelines. Additionally, Mission Bay has been designated a tax increment financing (TIF) district, with tax revenues going directly back to the district to build sewers, roads, and other infrastructure improvements. The project has received national acclaim for the research park's design and the win-win strategy developed by Catellus, the City of San Francisco, and UCSF.

Entrepreneurial Approaches – Stanford University is a prime example of how a university can take advantage of opportunities that will create value to the regional economy. Stanford is unique in that the university's different schools have parallel, yet successful tracks for supporting entrepreneurship within the framework of Stanford's risk taking culture. Stanford's Technology Ventures program, which is housed in the School of Engineering, provides courses and research on high-tech entrepreneurship for the university and other constituencies. The School of Business has taught entrepreneurship since the 1940s and the topic makes up 25 percent of all courses. Equally, the School of Law and School of Medicine have entrepreneurship programs for their students. Even faculty members have a generous leave of absence policy to pursue entrepreneurial ideas. Although the schools act independently, they are making more of an effort to collaborate with one another. The business school's business plan competition has brought together students from various programs to start new ventures. Organizations such as the student-run Business Association of Stanford Engineering Students (BASES) provide opportunity for engineering students to interact with their counterparts in law, business, and medicine through networking sessions, speaker series, and the organization-sponsored business plan competition

Bay Area Science Infrastructure Consortium (BASIC) – In a 1999 report, the Bay Area Economic Forum proposed the creation of a regional collaborative program dedicated to ensuring the support for Bay Area R&D facilities at the local, state, and federal levels. The consortium – which would consist of a board and steering committee made up of university, civic, government, and private sector leaders – would communicate to the region and government agencies the importance of the Bay Area's research institutions and facilitate collaboration among research laboratories, research universities and the private sector. BASIC represents a regional attempt for the public, private, and research sectors in the nine-county San Francisco-San Jose region to work together to support the Bay Area's R&D infrastructure. The consortium also provides a mechanism for an immediate regional response to issues of critical importance to the R&D community.

Foothill College – Nestled in the heart of Silicon Valley, Foothill College is a state-supported two-year college that is adept at meeting the workforce needs of the high-tech community. Foothill's mission is to have its students "educated to be trained" rather than simply trained. People change jobs so often and the technology changes so rapidly in the Bay Area that students need to have an education that is flexible enough to fill a variety of positions.

Foothill has produced several innovative education and training programs, partly due to the demand from the private sector, and partly due to competition from other community colleges (there are 26 community colleges in a 50-mile radius of Foothill). Currently, Foothill is partnering with semiconductor chip equipment manufacturer LAM Research Corporation to offer an Electromechanical Integrated Technology (EMIT) Industry Work Program. Foothill also has established an internship program with the NASA/Ames Research Center to support research related to aeronautics, space and earth sciences, life sciences, and computer systems research. Further, Foothill was the first community college in California to offer an online credit course.

Many large corporations in Silicon Valley such as Cisco Systems, 3-Com, and Hewlett-Packard have increasingly relied upon Foothill for talent. Still, Foothill has to educate many high-tech firms, particularly startups, about what a community college can offer. Despite this challenge, the college's success can be found in this simple fact: Foothill transfers more students to Stanford University over time than any institution in the country.

Lessons

Community Colleges and Cal State Universities play a significant role – Although the premier institutions such as Stanford, University of California-Berkeley and University of California-San Francisco dominate the higher-education environment in the Bay Area, they do not represent a complete picture of the regional wealth of colleges and universities. Community colleges, private colleges, and the state's four-year university system are major suppliers of technical talent. For example, San Jose State University graduates more engineering students that Stanford or UC Berkeley combined last year. With inexpensive full-time in-state tuition students have the opportunity to learn the skills that will allow them to enter the professional workforce of the Bay Area.

Competition is good – While there is a tremendous amount of collaboration occurring among the research institutions in the area, there is also a healthy amount of competition. Stanford and UC Berkeley are competing for the same students, researchers, and often, the same funding sources for projects. Among two-year institutions, 26 other community colleges in the region vie with Foothill College for students and funding. Even the major cities and counties in the Bay Area contend for new jobs and companies to locate in their jurisdictions. Public officials in Oakland, San Jose, San Francisco, and Berkeley rarely meet to discuss regional issues. Although the competition between the cities has been an obstacle to regional cooperation, business leadership groups such as, Joint Venture Silicon Valley Network, Silicon Valley Manufacturing Group, and the Bay Area Economic Forum are working to bring public, civic, and private sector officials together.

Continuous improvement – While the San Francisco Bay Area is unmatched in its R&D resources, it is not resting on its laurels. The Bay Area Economic Forum serves as a vehicle for Bay Area leadership in addressing issues that are vital to the region's future. The ability of the public and private sector to tackle difficult issues such as water transit, workforce development, housing, telecommunications infrastructure, and R&D infrastructure is testament to the Bay Area's determination to be the leading technology center in the world.

Other Regional Activities

Pittsburgh, Pennsylvania

Pittsburgh's Digital Greenhouse (PDG) is one of the country's most ambitious state-led initiatives to foster the growth of a high-tech industry. In June 1999, The Commonwealth of Pennsylvania sponsored the PDG to build an industry cluster around the application of System On Chip (SOC) technology in the digital media and digital networking markets.

The PDG is supported by a group of universities, foundations, and regional development organizations that provide financial support, technical guidance, and other in-kind services. These institutions include Carnegie Mellon University (CMU), the University of Pittsburgh, and Penn State. Member companies include Cadence Design Systems, Casio, Cisco Systems, Neolinear, Oki, Sima, Sony, and Tyco Electronics among others.

The Greenhouse was designed to attract new companies to the region, foster local companies to grow and support startups. Some of the programs the PDG is developing with its funds include the development of a collaborative

SOC program at the campuses of the three university partners and the development of a series of training modules that will provide practical SOC training to engineers with board and chip level design experience. Additionally, the Greenhouse is partnering with Cadence to offer an "Electronics Infusion" program to help Pennsylvania companies that are not traditional "electronics companies" utilize advanced electronics to improve their products or streamline their processes. Future plans for the PDG include the construction of a new chip design facility to provide a secure space for new firms moving to the region and existing companies to grow.

The PDG is just another extension of regional economic development leadership by CMU. Through its involvement with the Allegheny Conference on Community Development (a regional CEO business organization), Carnegie Mellon has been at the center of the ongoing efforts to reinvent Pittsburgh's economy. CMU's last three presidents have all been active leaders in the economic development strategies promoted by the Conference, and have recognized the connection between the University's historic science and technology leadership and the future of the region. In addition to PDG, specific actions the university has undertaken in recent years include:

- CMU staff support from its Center for Economic Development for economic development research conducted on behalf of the Working Together Consortium
- CMU partnership with the University of Pittsburgh and the Allegheny County RIDC in the development of the Pittsburgh Technology Center on the site of the former J&L Steel Mill in Pittsburgh

The University is also committed to expand technology commercialization in order to attract, grow, and retain businesses in the region through initiatives such as the creation of a venture capital fund, expanded technology transfer and business-support services.

Raleigh-Durham, North Carolina

North Carolina's prominence as a research and technology center is tied to the formation of the Research Triangle Park (RTP) in the late 1950s. The RTP is an example of public and private sector leaders mobilizing to respond to issues deemed critical to the state's economy. RTP was created for three reasons: 1.) To retain high-tech graduates in North Carolina, 2.) To attract high-tech firms with the lure of abundant land, and 3.) To foster partnerships between industry and the state's three most prominent research universities, Duke University, University of North Carolina, and North Carolina State University. The person who created the concept of Research Triangle Park, Romero Guest, believed a research park would diversify the state's economy, which was still dependent on tobacco, textiles, and furniture making.

The RTP was officially announced in 1959; and although growth in the park was slow in the early 1960s, the construction of facilities for IBM and the National Institute of Environmental Health Sciences (NIEHS) in 1965 helped build the momentum to recruit companies. The park has since grown into a major center for information technology, telecommunications, pharmaceuticals, microelectronics, environmental science and biotechnology. Currently, 136 companies own or lease more than 15 million square feet of space and employ more than 43,000 people. The investment has resulted in a research community that provides thousands of jobs to the State of North Carolina and attracts graduates and researchers from around the world.

Because of the RTP's success other efforts are underway to attract info-tech and biotech firms and foster new discoveries coming from the research universities. The most prominent is North Carolina State University creation of Centennial Campus, a 1,192-acre mixed-use research park that will employ more than 25,000 people when completed. The effort will provide potential tenants office and lab space in an urban setting next to a research university. Centennial Campus will take between 25 to 50 years to build and more than $2 billion will be invested in the project by public and private entities.

While the RTP has been a tremendous economic benefit for the region, it does not conform to the necessities of research parks being constructed today. High growth biotechnology and information technology firms are eager to find space in an urban setting that is close to a major research university. North Carolina State University is responding to this need.

The university and private developers have invested more than $340 million in constructing a new research campus that will bring national stature to the university and allow the institution to step out from the shadows of nearby Research Triangle Park. Currently, 15 buildings constituting 1.3 million square feet have been completed with 13 additional buildings scheduled to open by the end of 2001. The 1,192-acre Centennial Campus will take between 25 to 50 years to complete and will function in many ways like a small city. The research campus will feature a golf

course, a retirement community, a public middle school, a light-rail transit system, single-family homes, and retail establishments. Open space and meeting areas will be designed around the cluster of buildings to encourage everyday interaction between members of the local community, academics and company employees. The project is a calculated gamble for the university, but companies and academic departments alike are eager to relocate to Centennial. Currently, sixty companies rent space at Centennial, including Daimler-Chrysler, Ford, Bayer, Lucent Technology, and Motorola. Additionally, North Carolina State has created a $10 million venture capital fund to help start companies that can market promising research.

The university system has not been able to rely on budget reserves to finance construction because of the devastation by recent hurricanes and floods. Although a few buildings have been built with state-appropriated money, the majority has been paid for by state bonds and private developers who leased the land for about $15,000 an acre. Professors and departments that want to locate to buildings financed by bonds and developers must pay rent. This has forced departments to become more entrepreneurial and find outside funds to help pay for space.

Atlanta, Georgia

Atlanta's strength in the life sciences can be traced back to the creation of the Centers for Disease Control (CDC) in the late 1940s. Originally named the "Communicable Disease Center", the organization was created to work with state and local officials in the fight against malaria, still prevalent in many southern communities. Since then, the CDC has expanded its mission to become the country's leading center for the study and prevention of communicable and infectious diseases. Approximately 4,600 CDC employees work in the Atlanta area, of which more than 1,600 are located at the agencies headquarters on Clifton Road.

Atlanta also is a hotbed for engineering and information technology. Georgia Institute of Technology is nationally ranked in engineering, computer science, and business. The region's other research universities -- Georgia State University, Clark Atlanta University, the University of Georgia, Emory University, and Morehouse School of Medicine – along with other private colleges graduate provide talented graduates in engineering, medicine, information technology, and other disciplines that will create new ventures or work for many of the region's high-tech companies.

Atlanta civic, government, and private sector leaders have realized the importance of its colleges and universities as an economic engine and have coordinated efforts to strengthen its institutions. Last year, the Atlanta Regional Consortium for Higher Education (ARCHE), a non-profit research and advocacy group, documented how higher education activity in the Atlanta region compares with the nation's metropolitan areas. ARCHE provides its member institutions with services that help to expand educational opportunities, as well as communicate to civic and business leaders and the general public of the ways in which higher education benefits the Atlanta region and the State of Georgia.

The Metro Atlanta Chamber of Commerce also is actively involved in the region talent capacity. In 1997 the Chamber convened a small group of the region's top business leaders to provide guidance to the new staff leadership. The group decided that the next economic development strategy would be to attract technology industries with significant growth potential. The Chamber commissioned Andersen Consulting to study the metro area's technology clusters to identify local concentration of technology industries that met the Chamber's growth criteria and had the greatest attraction potential. The study revealed four technology industries as possible economic development targets for the Chamber: telecommunications, high-tech manufacturing, software and computer-related services; and, biotechnology.

From these "industries of the mind" (IOM) the Chamber next sought assistance from KPMG Peat Marwick to develop a marketing campaign to attract these targeted industries. KPMG's analysis revealed that the labor force ranked as the top location criteria among all technology sectors. The Chamber responded by forming a five-year talent growth strategy that would help graduate more local students in IT related fields and increase the number of professional moving to Metro Atlanta. The Chamber has set up a separate IOM program led by a seasoned high-tech economic development professional. The program makes marketing trips, sends e-mail newsletters to site consultants, targets high-tech cities and their regional universities with strong technology programs, and manages a website (AtlantaSmartCity.com).

On a statewide level, the Georgia Research Alliance (GRA) is assisting the state in making strategic investments in R&D capabilities at Georgia's most prominent research universities. In 1990, a group of prominent businessmen created the GRA to provide a mechanism for collaboration and cooperation among the state's research universities. The business leaders conceived the GRA as "an opportunity to promote science-based development to a new

governor and assured the proposal would get favorable consideration by lobbying both candidates prior to the election."[31] The GRA is a public/private partnership consisting of twelve CEOs of Georgia-based companies and the presidents of six Georgia research universities (Georgia Tech, University of Georgia, Emory University, Medical College of Georgia, Georgia State University, and Clark Atlanta University). The Alliance's mission is to make strategic investments in R&D capabilities at the member universities. State funds have been appropriated for GRA investments in such activities as the recruitment of distinguished researchers (Eminent Scholars) upgrading/modernizing research facilities, and purchasing new equipment and instrumentation as cost sharing for proposed federal R&D contracts. Recently, the GRA and its member universities announced that it would launch a multimillion-dollar strategy aimed at making the state a national leader in the bioinformatics field.

San Diego, California

The fast-growing San Diego region has received national and international recognition for its cluster of biotechnology assets. According to the San Diego Economic Development Corporation (SDEDC), San Diego boasts over 240 companies that are involved in the research and development of products that require FDA approval. The region's research institutions are at the hub of San Diego's biotechnology boom. The University of California – San Diego (UCSD), The Salk Institute, the Scripps Research Institute, and The Burnham Institute provide cutting-edge research in such areas as immunology, AIDS, molecular and cellular biology, and degenerative diseases. Nearly 150 biotechnology companies have spun-off from UCSD research alone. Overall, San Diego biotech companies employ more than 18,000 employees and have annual revenues in excess of $1.8 billion, according to SDEDC.

San Diego also has a long tradition as a center for the defense and aerospace industry. The Navy has designated San Diego a "Megaport" and the region is home to the Space and Naval Warfare Systems Center (SPAWAR). With an annual operating budget of $3 billion, SPAWAR is responsible for development of the technology to collect, transmit, process, display, and manage information essential to the Navy's operations. San Diego received $7.1 billion in Pentagon spending during 1999, the second highest amount in the country, according to a US Department of Commerce report. Because of the defense concentration, hundreds of software, telecommunications, and information technology companies have settled in San Diego to help support defense industry efforts.

The proximity to Mexico gives San Diego an additional advantage over other metropolitan areas in attracting consumer electronics, information technology and communications firms. International firms from Asia and Europe locate in the San Diego/Baja California region to access the North American market and benefit from the NAFTA's preferential duty treatment. San Diego's cluster of software, telecommunications and information technology firms provides an atmosphere conducive for conducting research and development, while Mexico's lower labor costs and skilled workforce offers an outlet for manufacturing high-quality products inexpensively. Firms that have operations in both San Diego and Baja California include Sanyo, Samsung, Koycera (a semiconductor manufacturer), and Hughes.

[31] Richard S. Combes and William J. Todd, From Henry Grady to the Georgia Research Alliance: A Case Study of Science-Based Development in Georgia, p. 14.

DIRECTIONS FOR THE FUTURE OF PHILADELPHIA'S KNOWLEDGE INDUSTRY

It is clear that if Greater Philadelphia wants to be counted among the top knowledge regions in the country, it must be prepared to seize opportunities that build upon its current base of assets – to both keep up with the national leaders and to hold off those regions trying to rise to the top. This is not an easy task – moving forward will require a degree of coordination and strategy that does not come naturally to the knowledge industry. Luckily, we have a model that gives us an idea of what we could do – the growing hospitality industry, fresh off the home run of the Republican Convention. This section links our knowledge industry future to the story of Philadelphia's hospitality industry and sets some ambitious goals with possible strategies for getting there.

If success in the new economy will be increasingly concentrated in those regions with the right combination of smart people and good ideas, it is crucial that Greater Philadelphia be well positioned to capitalize and build upon its existing base of knowledge assets. The region is starting from a good place – over the past 250 years, the Philadelphia region has built a knowledge infrastructure that is competitive with any in the world. What we now need to do is honestly evaluate our current standing, and be prepared to invest and seize opportunities in order to position the region as a leader in the 21st Century.

We are not alone in this pursuit. Other regions and states are acting aggressively and decisively to attract research dollars, recruit eminent scholars, and connect the research and talent in their higher education institutions to their local economies. It is clear that the region's knowledge industry must become bigger, better and more well known in order to position the region to capitalize on the new science-based economy. That will require a sophisticated and coordinated mix of planning, investment, and marketing that will result in a knowledge industry base that supports and generates private investment and development throughout the region.

The region stepped up to a similar challenge in the past decade. For years, Philadelphians wondered why we were not getting our share of tourism dollars. Yet when we looked honestly at our assets, we realized that we had been coasting on our historic reputation, rather than striving to be competitive with the leaders in the industry. To some, the Civic Center was perfectly fine as a convention center facility – yet we now realize that the investment in a world-class convention center was necessary for success. When the Pew Charitable Trusts commissioned an analysis of the region's hospitality potential, it quickly become apparent that Philadelphia was slipping far behind other regions when it came to marketing and promoting our wealth of assets. Undertaking such a campaign required new thinking, planning, and significant investment of public, private, and charitable funds. However, it is now clear that the investment in and creation of the Greater Philadelphia Tourism Marketing Corporation was a key factor in the region's recent success. And finally, even as we began to realize the potential of our tourism industry, we did come to grips with the understanding that it would not be enough to live off of our historical assets and success stories. Major investments in the core infrastructure of the industry – hotels, the airport, new tourist attractions like Lights of Liberty, the Constitution Center, and even the Performing Arts Center – were required to keep Philadelphia in the top echelon of tourist destination cities. The capstone of the effort – the attraction of the 2000 Republican National Convention – was the culmination of over 20 years of planning, building, organizing, and investing in a hospitality industry that could now claim to be in the upper echelon of hospitality industries in the country.

Yet even after the success of the RNC, it is clear that we cannot rest for even a moment. It is likely that we will need to invest in an expanded convention center, just to keep up with the aggressive investments and actions of our competitors. And we will need to work harder to extend stays of visitors and to fill the rooms of our expanded hotel market.

The knowledge industry is in a similar position. For years, we have drifted along, believing that we were a national leader. Yet it is clear that we are not in the top echelon of knowledge regions with Boston, the San Francisco Bay Area, New York, Los Angeles and Chicago, and we run the risk of being surpassed from behind by regions like Raleigh-Durham, Atlanta, and San Diego. If we are to be competitive in the knowledge-based economy, the region must be ready to make the investments and commitments necessary to be competitive.

Where should we be headed? The region needs to invest in increasing both the size and quality of its knowledge industry, in order to provide both the workers and the ideas necessary for regional economic success. It must also increase the visibility and reputation of the region's knowledge industry, using sophisticated and targeted marketing campaigns to appeal to a variety of audiences, including potential students, potential researchers, potential investors, and businesses. Following are specific goals, followed by potential strategies that could be employed to meet the challenges faced by the region.

Grow the Talent Base

Greater Philadelphia's knowledge industry is caught in the middle. While the enrollment at regional institutions seems large – over 213,000 FTE students – the region only ranks seventh in terms of total enrollment, despite being the 6th largest region in the country (in terms of population). Of perhaps even greater concern is the concentration of students among the region's population and the fact that other regions' student populations have grown by far larger numbers than in Greater Philadelphia. Highly concentrated regions gain a reputation as "collegetowns" – centers of knowledge and learning where it is relatively easy for employers to identify and recruit the talent necessary to fuel growing companies. It is easy to point to small towns like State College, PA or Madison, WI where a single university dominates the economic landscape and say it will be impossible for Philadelphia to match that concentration. It should be of more concern when major metropolitan regions – places like Boston, the San Francisco Bay Area, San Diego, or Denver – have a much greater concentration of students than Philadelphia. It is no accident that these regions also appear at or near the top of most measures of high-tech activity or entrepreneurial hot spots.

Where does this lead us? If Philadelphia wants to maintain or improve its position as a knowledge region, it must increase both the number of students being educated at regional institutions and the pool of research dollars coming through regional institutions. The first step would be to bring Philadelphia's student concentration to the same ratio as its overall population – that would mean adding 20,000 more FTE students, or the equivalent of graduating 5,000 more students a year. The increase should be strategic, and should focus on specifically increasing the number of students being trained in technical fields, like engineering and the physical sciences, as well as the basic life sciences where the region lags national concentrations of graduates at various levels. In addition, the gains should be at all levels – associates, bachelors, and masters degrees in all of the disciplines.

What are the benefits of expanding the student pool? Meeting the employment needs of regional technology employers. Potentially reversing the aging of the region by drawing in and keeping more young people. And increasing local and national attention on Philadelphia as a place that welcomes and encourages young people to learn, live, and work here.

Potential Strategies

There are a number of ways that the region could add more college students to its population, none of which are mutually exclusive:

- **Market Philadelphia as a center of higher education to graduating seniors and potential graduate students, expanding the pool of potential applicants for local institutions.** This should be an opportunity to build upon the Campus Visit efforts begun in 1999 by GPTMC with a well-funded, targeted message to students in the mid-Atlantic region. In addition, international recruitment efforts should be explored, promoting Philadelphia as a city with numerous educational alternatives and options.
- **Strategically expand existing institutions with the room and inclination to grow.** Clearly, not every institution is in a position to expand, but those looking to expand should be encouraged to do so. In recent years, Temple has increased applications and acceptances significantly, as well as increasing the number of students living on campus. Campus expansion programs can be used for community revitalization in those areas where there is room for growth and development.

- **Establish a new technical, research-based state institution.** The quickest way to boost regional enrollment could be through the establishment of a brand-new institution. Around the country, former military facilities and corporate campuses have been converted in public colleges and universities. Perhaps the most prominent start-up has been the conversion of the former Fort Ord army base into the University of California—Monterrey Bay. Vacant properties with existing infrastructure, like those at the Philadelphia Navy Yard, or in some of the empowerment zone areas in Philadelphia and Camden could be considered as new campuses of state universities or colleges.

Grow the Idea Base

At the same time, the region's research base is a crucial element for future growth in the region as a source of new ideas for existing companies and new companies themselves. The region ranks seventh in research funding, but that research base rests disproportionately on the shoulders of the University of Pennsylvania and is heavily concentrated in the medical sciences. The leading research regions have multiple poles of institutional research strength, as well as stronger bases of research in the basic life sciences, physical sciences, computer sciences and engineering, while remaining strong in medical sciences.

The region should also be concerned about the relatively low ranking of its institutions. Whether one likes the *US News* rankings or not, it is impossible to ignore the fact that the Philadelphia region lags the national leaders in institutional and program rankings. High rankings help to attract students, faculty, and researchers (and research dollars) to the region. They also burnish the region's reputation as a center of knowledge – important in the knowledge economy for attracting people with hot ideas and the money to fuel them.

What are some of the key factors in increasing both the research dollar pool and the quality rankings of institutions? One is recruiting star faculty. A number of regions have set into place strategies to actively recruit and lure star researchers and faculty to their regions to bring their research dollars, reputations, and star students with them. The region's business and civic leadership should set out to recruit a specific number of star researchers to the region – 50 over 10 years – working closely with regional institutions to endow professorships to meet specific regional economic development and research goals. With this, the region should be able to move into the top five of regional rankings for quality of institutions and programs.

Another key factor is cooperation. In a number of regions and states, major research institutions are banding together to increase the pool of research dollars coming into a region. With coordinated approaches, involving both academic and private leadership, the regions are better able to approach government leaders with specific requests for funding, including capital requests. Philadelphia needs to ensure that it maintains its current position, and should set a goal to move into the top five regions for research funding, which would likely require doubling our R&D expenditures. This goal will challenge other institutions (or new institutions) to step up and expand their research programs to provide a counterbalance for the University of Pennsylvania.

Potential Strategies

There are a number of potential strategies for enhancing the region's reputation as a knowledge region and research base**:**

- **Create a research alliance of leading research institutions and private sector leaders.** There is a need for focused attention on the research needs of the region's primary research institutions. By bringing together academic and business leadership, there is an opportunity to strategically address the needs of both the region's business and academic community by working together to recruit and attract top researchers and research funding to the region. In other regions, research and business leaders go together to Washington and their state capitols to lobby for capital and research funding, providing the government leaders with an increased confidence that the needs are part of a strategic plan. The creation of an alliance also provides the ongoing capacity for the region to seek out and attract additional research institutions, whether they be government funded centers (NIH or Defense research labs or centers) or private opportunities (Wellcome Trust, Rand, or other private research facilities).
- **Build a strategic industry-academic consortium in the life sciences to help spur the creation of an industry in the region**. Following the lead of Pittsburgh's Digital Greenhouse, the region should focus on developing the life sciences equivalent, bringing together private and academic interests to push the envelope in identifying specific market niches where the region can be an international leader. A virtual research center of

this type can help to create a buzz about the region that can lend credibility to marketing efforts to brand the region as a leading knowledge region.

- **Raise a pool of private funds to support the establishment of endowed chairs at regional research institutions**. The intensity of the competition for star faculty members who can improve institutional rankings and bring in research dollars is intensifying. Other regions are establishing pools of funds to attract the leading biotech and information technology experts to their region. Greater Philadelphia must be prepared to compete with other regions to both attract new brains to campuses and keep our best at home.

Build an Identity and Image for Philadelphia's Knowledge Industry

Despite concerns about size and quality, Philadelphia remains well positioned to assume a role as the research hub of the Mid-Atlantic region. Ideally situated between the international financial capitol of New York and the regulatory and governmental capitol of Washington, DC, the region should be aspiring to assume a knowledge-capitol role similar to that played by Boston in New England. Because both New York and the Washington-Baltimore areas are too big and diverse to be able to claim their areas as knowledge regions, Philadelphia has the opportunity, particularly with a life sciences focus, to claim that mantle. It is a perfect niche for Philadelphia to fill, and it helps to link the region to institutions in New York and Washington, allowing the region to play taller than it currently is while it builds a stronger critical mass of knowledge assets.

If the region is to become the knowledge capital, it also needs a clearly identifiable center of the region's knowledge industry – akin to Cambridge in Boston or the Research Triangle Park in Raleigh-Durham. These are places where knowledge and business intersect and overlap, and where it is clear that knowledge assets are primary factors for the success and growth of industry. Philadelphia's natural corollary to Cambridge is University City. University City is the home to 3 universities, five medical centers, and the University City Science Center. Yet, it has yet to become a hotbed of private activity, despite the best efforts of the Science Center over the years.

However, the opportunity is now ripe to build upon those assets and make University City the focal point of Greater Philadelphia's Knowledge Industry. The actions of the University City District and the University of Pennsylvania have helped to stabilize and energize the University City community, and there are a number of key opportunities that will be emerging in the coming years that should lead to significant private interest. First, the Amtrak high-speed corridor will open, bringing both New York and Washington-Baltimore closer to University City and 30th Street Station. The Postal Service will be vacating much of its property along the Schuylkill River south of the train station, allowing for potential private development that is linked to the university-hospital research complexes. And, finally the strengthening of Center City as both a business and residential location has created opportunities for new development, which could be focused to west, effectively linking University City and Center City as a new economy business center. This challenge would require significant leveraging of private sector investment, as seen in other regions, where private sector investment tied to university-related economic development strategies have reached a billion dollars.

Potential Strategies

Potential strategies for branding Philadelphia as a true knowledge region include:

- **Maximize research and development business opportunities in University City.** University City is the natural hub of the region's knowledge industry, and its linkages to Center City should make it a natural center for research-based business activity. Every effort should be made to utilize the Keystone Opportunity Zone incentives and other economic development programs like TIFs to build a critical mass of business and research activity in University City and crossing the river into Center City West. University City has a unique opportunity to combine elements of both Cambridge and the Research Triangle in an area immediately adjacent to the region's hub of business activity, with its lawyers, business consultants, accountants, and financiers.
- **Marketing the region as a knowledge hub.** A comprehensive regional marketing strategy should be developed that realistically highlights the region's strength as a knowledge center, while also focusing on the ongoing efforts to invest and build upon those assets. No longer is it enough to tell a story of what you have or had – it is just as important to tell the story of what you are doing to continuously improve and grow the region's knowledge base.

Why Act Now?

The research contained within this collection of stories is not designed to depress or intimidate regional leaders. Rather, it is designed to challenge the region to think strategically about its future, to build upon a set of good, but maybe not great, assets, and to dare to think big when it comes to our future. No longer is it enough to be satisfied with being good. The leading regions are undertaking major initiatives designed to maintain and even surpass their current positions as the nation's leaders. Greater Philadelphia really has no choice if it wants to compete in the new knowledge-based economy. It must recognize that other regions – both ahead of and behind us – are daring to innovate and change their ways of thinking and are already acting aggressively to pursue many of the opportunities laid out here. If the region is satisfied with the status quo and does not act, it is likely to be in a position 10 years from now wondering why regions like Atlanta and San Diego and Houston and Pittsburgh – places without the history or reputation of Philadelphia as a knowledge region – are the centers of the new "New" economy. For the future of the region, we cannot afford to be in that position.

APPENDIX A: REGIONAL RANKINGS

Total Full-Time Equivalent (FTE) Enrollment*

1.	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA	703,831
2.	Los Angeles-Riverside-Orange County, CA CMSA	535,679
3.	Chicago-Gary-Kenosha, IL-IN-WI CMSA	321,590
4.	San Francisco-Oakland-San Jose, CA CMSA	309,838
5.	Boston-Worcester-Lawrence-Lowell-Brockton, MA-NH NECMA	268,778
6.	Washington-Baltimore, DC-MD-VA-WV CMSA	264,545
7.	Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD CMSA	213,446
8.	Detroit-Ann Arbor-Flint, MI CMSA	173,790
9.	Dallas-Fort Worth, TX CMSA	137,742
10.	San Diego, CA MSA	128,408
11.	Seattle-Tacoma-Bremerton, WA CMSA	127,866
12.	Houston-Galveston-Brazoria, TX CMSA	113,130
13.	Phoenix-Mesa, AZ MSA	107,985
14.	Minneapolis-St. Paul, MN-WI MSA	104,789
15.	Denver-Boulder-Greeley, CO CMSA	103,992
16.	Atlanta, GA MSA	102,731
17.	Miami-Fort Lauderdale, FL CMSA	98,530
18.	Pittsburgh, PA MSA	91,641
19.	Cleveland-Akron, OH CMSA	83,758
20.	Austin-San Marcos, TX MSA	80,441

Source: PEL calculations based on data from the National Center for Employment Statistics (NCES)/Integrated Post-Secondary Education Data System (IPEDS), Fall Enrollment 1997. *Full-time equivalent is the sum of all full-time students and 1/3 of part-time students.

Number of Institutions

1.	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA	233
2.	Los Angeles-Riverside-Orange County, CA CMSA	139
3.	Chicago-Gary-Kenosha, IL-IN-WI CMSA	108
4.	Boston-Worcester-Lawrence-Lowell-Brockton, MA-NH NECMA	103
5.	San Francisco-Oakland-San Jose, CA CMSA	102
6.	Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD CMSA*	83
7.	Washington-Baltimore, DC-MD-VA-WV CMSA	82
8.	Minneapolis-St. Paul, MN-WI MSA	49
9.	Pittsburgh, PA MSA	48
10.	Dallas-Fort Worth, TX CMSA	44
11.	Seattle-Tacoma-Bremerton, WA CMSA	43
12.	Detroit-Ann Arbor-Flint, MI CMSA	42
13.	Atlanta, GA MSA	39
14.	Phoenix-Mesa, AZ MSA	35
15.	Houston-Galveston-Brazoria, TX CMSA	33
16.	Denver-Boulder-Greeley, CO CMSA	33
17.	San Diego, CA MSA	33
18.	Portland-Salem, OR-WA CMSA	32
19.	Kansas City, MO-KS MSA	32
20.	St. Louis, MO-IL MSA	31

Source: PEL calculations based on data from NCES/IPEDS, Institution Characteristics, 1997-98. *Two institutions were added into Philadelphia's total count (New Jersey Institute of Technology-Mt. Laurel and University of Medicine and Dentistry-Camden and Stratford Campuses). These institutions have a significant presence region, however they are not counted as separate institutions in IPEDS.

Total Institutional Expenditures

1.	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA	$15,830,119,411
2.	Los Angeles-Riverside-Orange County, CA CMSA	$8,895,321,161
3.	Boston-Worcester-Lawrence-Lowell-Brockton, MA-NH NECMA	$7,509,611,072
4.	Washington-Baltimore, DC-MD-VA-WV CMSA	$7,259,926,087
5.	Chicago-Gary-Kenosha, IL-IN-WI CMSA	$7,179,355,473
6.	San Francisco-Oakland-San Jose, CA CMSA	$6,699,443,405
7.	Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD CMSA	$6,411,302,583
8.	Detroit-Ann Arbor-Flint, MI CMSA	$4,122,628,680
9.	Raleigh-Durham, NC MSA	$3,250,724,444
10.	Houston-Galveston-Brazoria, TX CMSA	$3,057,057,860
11.	Atlanta, GA MSA	$2,604,457,966
12.	Minneapolis-St. Paul, MN-WI MSA	$2,546,136,147
13.	Seattle-Tacoma-Bremerton, WA CMSA	$2,396,456,481
14.	San Diego, CA MSA	$2,098,376,137
15.	Dallas-Fort Worth, TX CMSA	$2,030,962,316
16.	Pittsburgh, PA MSA	$1,860,671,186
17.	St. Louis, MO-IL MSA	$1,823,175,086
18.	Columbus, OH MSA	$1,820,182,157
19.	Miami-Fort Lauderdale, FL CMSA	$1,757,258,301
20.	Denver-Boulder-Greeley, CO CMSA	$1,592,602,398

Source: PEL calculations based on data from IPEDS/NCES, Finances 1995-96

Total R&D Expenditures

1.	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA	$1,759,260,000
2.	Washington-Baltimore, DC-MD-VA-WV CMSA	$1,583,370,000
3.	San Francisco-Oakland-San Jose, CA CMSA	$1,290,828,000
4.	Boston-Worcester-Lawrence-Lowell-Brockton, MA-NH NECMA	$1,216,462,000
5.	Los Angeles-Riverside-Orange County, CA CMSA	$1,156,350,000
6.	Raleigh-Durham, NC MSA	$772,917,000
7.	Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD CMSA	$665,807,000
8.	Chicago-Gary-Kenosha, IL-IN-WI CMSA	$654,287,000
9.	Detroit-Ann Arbor-Flint, MI CMSA	$644,879,000
10.	Houston-Galveston-Brazoria, TX CMSA	$643,966,000
11.	Atlanta, GA MSA	$524,938,000
12.	San Diego, CA MSA	$462,209,000
13.	Madison, WI MSA	$443,695,000
14.	Seattle-Tacoma-Bremerton, WA CMSA	$432,383,000
15.	Bryan-College Station, TX MSA	$393,720,000
16.	Minneapolis-St. Paul, MN-WI MSA	$362,810,000
17.	State College, PA MSA	$362,643,000
18.	Pittsburgh, PA MSA	$352,589,000
19.	Denver-Boulder-Greeley, CO CMSA	$343,333,000
20.	Champaign-Urbana, IL MSA	$338,841,000

Source: PEL calculations based on data from the National Science Foundation (NSF), Academic Research and Development Expenditures, Fiscal Year 1998 (early release tables)

Total Degrees Conferred (All Levels of Study)

1.	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA	170,377
2.	Los Angeles-Riverside-Orange County, CA CMSA	100,108
3.	Boston-Worcester-Lawrence-Lowell-Brockton, MA-NH NECMA	72,348
4.	Chicago-Gary-Kenosha, IL-IN-WI CMSA	70,433
5.	Washington-Baltimore, DC-MD-VA-WV CMSA	66,319
6.	San Francisco-Oakland-San Jose, CA CMSA	59,990
7.	Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD CMSA	51,078
8.	Detroit-Ann Arbor-Flint, MI CMSA	42,035
9.	Seattle-Tacoma-Bremerton, WA CMSA	29,331
10.	Dallas-Fort Worth, TX CMSA	29,154
11.	Miami-Fort Lauderdale, FL CMSA	25,781
12.	Denver-Boulder-Greeley, CO CMSA	23,941
13.	Pittsburgh, PA MSA	23,923
14.	Minneapolis-St. Paul, MN-WI MSA	23,321
15.	San Diego, CA MSA	23,259
16.	Atlanta, GA MSA	21,824
17.	St. Louis, MO-IL MSA	20,856
18.	Phoenix-Mesa, AZ MSA	20,808
19.	Houston-Galveston-Brazoria, TX CMSA	20,291
20.	Albany-Schenectady-Troy, NY MSA	20,270

Source: PEL calculations based on data from NCES/IPEDS, Completions 1996-97

Patents Issued

1.	Boston-Worcester-Lawrence-Lowell-Brockton, MA-NH NECMA	405
2.	San Francisco-Oakland-San Jose, CA CMSA	200
3.	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA	190
4.	Los Angeles-Riverside-Orange County, CA CMSA	157
5.	Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD CMSA	131
6.	Washington-Baltimore, DC-MD-VA-WV CMSA	109
7.	Raleigh-Durham, NC MSA	104
8.	Chicago-Gary-Kenosha, IL-IN-WI CMSA	83
9.	Madison, WI MSA	78
10.	Detroit-Ann Arbor-Flint, MI CMSA	71
11.	San Diego, CA MSA	65
12.	Seattle-Tacoma-Bremerton, WA CMSA	62
13.	Lansing-East Lansing, MI MSA	61
14.	Atlanta, GA MSA	57
15.	Gainesville, FL MSA	51
16.	Houston-Galveston-Brazoria, TX CMSA	50
17.	Rochester, NY MSA	48
18.	St. Louis, MO-IL MSA	42
19.	Cleveland-Akron, OH CMSA	38
20.	Minneapolis-St. Paul, MN-WI MSA	38

Source: PEL calculations based on data from the Association of University Technology Managers (AUTM), FY1998 Licensing Survey.
Note: Data in the AUTM report are reported by and for AUTM member institutions only. Estimates were made for institutions that were reported as part of a system of institutions (i.e., University of Massachusetts), except for institutions of the University of California System, whose figures were obtained from the FY99 Annual Report of the UC Technology Transfer Program.

Licenses and Options Executed

1. New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA..... 293
2. Boston-Worcester-Lawrence-Lowell-Brockton, MA-NH NECMA..... 282
3. San Francisco-Oakland-San Jose, CA CMSA..... 187
4. Washington-Baltimore, DC-MD-VA-WV CMSA..... 173
5. Los Angeles-Riverside-Orange County, CA CMSA..... 170
6. Raleigh-Durham, NC MSA..... 154
7. Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD CMSA..... 141
8. Seattle-Tacoma-Bremerton, WA CMSA..... 128
9. Athens, GA MSA..... 94
10. Madison, WI MSA..... 75
11. Chicago-Gary-Kenosha, IL-IN-WI CMSA..... 66
12. Minneapolis-St. Paul, MN-WI MSA..... 65
13. Houston-Galveston-Brazoria, TX CMSA..... 62
14. Bryan-College Station, TX MSA..... 54
15. San Diego, CA MSA..... 53
16. Detroit-Ann Arbor-Flint, MI CMSA..... 52
17. State College, PA MSA..... 42
18. Birmingham, AL MSA..... 41
19. St. Louis, MO-IL MSA..... 40
20. Atlanta, GA MSA..... 39

Source: PEL calculations based on data from AUTM, FY1998 Licensing Survey. Note: Data in the AUTM report are reported by and for AUTM member institutions only. Estimates were made for institutions that were reported as part of a system of institutions (i.e., University of Massachusetts), except for institutions of the University of California System, whose figures were obtained from the FY99 Annual Report of the UC Technology Transfer Program.

APPENDIX B: STATE RANKINGS

Total Full-Time Equivalent (FTE) Enrollment*

1.	California	1,267,407
2.	New York	787,853
3.	Texas	675,897
4.	Illinois	493,027
5.	Pennsylvania	464,397
6.	Florida	431,148
7.	Ohio	397,930
8.	Michigan	370,584
9.	Massachusetts	313,312
10.	North Carolina	281,180
11.	Virginia	259,535
12.	Georgia	235,967
13.	Indiana	230,344
14.	New Jersey	227,309
15.	Washington	226,242
16.	Wisconsin	220,891
17.	Missouri	216,139
18.	Minnesota	201,856
19.	Alabama	195,582
20.	Tennessee	194,428

Source: PEL calculations based on data from the National Center for Employment Statistics (NCES)/Integrated Post-Secondary Education Data System (IPEDS), Fall Enrollment 1997. * Full-time equivalent is the sum of all full-time students and 1/3 of part-time students.

Number of Institutions

1.	California	349
2.	New York	296
3.	Pennsylvania	228
4.	Texas	184
5.	Ohio	157
6.	Illinois	155
7.	Massachusetts	119
8.	North Carolina	118
9.	Florida	112
10.	Michigan	102
11.	Missouri	97
12.	Minnesota	95
13.	Georgia	94
14.	Indiana	91
15.	Virginia	89
16.	Tennessee	78
17.	Alabama	72
18.	Washington	69
19.	Wisconsin	63
20.	Colorado	63

Source: PEL calculations based on data from NCES/IPEDS, Institution Characteristics, 1997-98.

Total Institutional Expenditures

1.	California	$21,380,986,855
2.	New York	$18,406,864,649
3.	Pennsylvania	$11,884,564,199
4.	Texas	$10,780,103,437
5.	Illinois	$9,668,985,665
6.	Massachusetts	$8,580,973,720
7.	Ohio	$7,181,614,694
8.	Michigan	$7,107,984,725
9.	North Carolina	$6,181,789,186
10.	Florida	$5,853,716,371
11.	Georgia	$4,875,646,214
12.	Virginia	$4,552,057,059
13.	Maryland	$4,315,457,635
14.	Indiana	$4,257,489,886
15.	Wisconsin	$4,007,022,007
16.	Missouri	$3,969,387,744
17.	Tennessee	$3,747,841,681
18.	Minnesota	$3,695,561,422
19.	Washington	$3,653,582,653
20.	New Jersey	$3,578,988,987

Source: PEL calculations based on data from IPEDS/NCES, Finances 1995-96

Total R&D Expenditures

1.	California	$3,344,740
2.	New York	$1,919,558
3.	Texas	$1,696,004
4.	Pennsylvania	$1,341,607
5.	Maryland	$1,330,170
6.	Massachusetts	$1,267,701
7.	Illinois	$1,045,800
8.	North Carolina	$898,513
9.	Michigan	$877,804
10.	Ohio	$808,210
11.	Georgia	$802,023
12.	Florida	$712,704
13.	Wisconsin	$535,775
14.	Washington	$534,410
15.	Virginia	$490,695
16.	Colorado	$489,419
17.	New Jersey	$484,642
18.	Missouri	$484,159
19.	Alabama	$442,196
20.	Indiana	$425,293

Source: PEL calculations based on data from the National Science Foundation (NSF), Academic Research and Development Expenditures, Fiscal Year 1998 (early release tables)

Total Degrees Conferred (All Levels of Study)

1.	California	235,986
2.	New York	208,171
3.	Texas	129,168
4.	Florida	113,299
5.	Pennsylvania	112,327
6.	Illinois	110,578
7.	Ohio	92,798
8.	Michigan	87,227
9.	Massachusetts	82,320
10.	North Carolina	60,942
11.	Virginia	56,734
12.	Missouri	52,080
13.	Washington	51,493
14.	Indiana	50,645
15.	Georgia	49,865
16.	Alabama	49,812
17.	New Jersey	49,037
18.	Wisconsin	45,281
19.	Minnesota	42,295
20.	Maryland	41,657

Source: PEL calculations based on data from NCES/IPEDS, Completions 1996-97

Patents Issued

1.	California	466
2.	Massachusetts	412
3.	New York	228
4.	Pennsylvania	182
5.	Michigan	132
6.	Texas	127
7.	North Carolina	119
8.	Maryland	109
9.	Illinois	106
10.	Ohio	103
11.	Florida	93
12.	Georgia	81
13.	Wisconsin	78
14.	Iowa	76
15.	Washington	73
16.	Minnesota	64
17.	Virginia	52
18.	Indiana	51
19.	Louisiana	47
20.	Missouri	46

Source: PEL calculations based on data from the Association of University Technology Managers (AUTM), FY1998 Licensing Survey.
Note: Data in the AUTM report are reported by and for AUTM member institutions only.

Licenses and Options Executed

1.	California	442
2.	New York	319
3.	Massachusetts	285
4.	Pennsylvania	215
5.	Iowa	213
6.	Maryland	170
7.	Texas	166
8.	North Carolina	164
9.	Washington	150
10.	Georgia	133
11.	Illinois	104
12.	Minnesota	102
13.	Michigan	89
14.	Wisconsin	75
15.	New Jersey	70
16.	Tennessee	63
17.	Ohio	61
18.	Utah	58
19.	Connecticut	57
20.	Indiana	53

Source: PEL calculations based on data from AUTM, FY1998 Licensing Survey. Note: Data in the AUTM report are reported by and for AUTM member institutions only.

APPENDIX C: NOTES ON METHODOLOGY

Regional Institution Counts

Institutions were identified using data provided by the National Center for Education Statistics' (NCES) through the Integrated Post-Secondary Education Data System (IPEDS). Specifically, "completions" data (i.e., degrees conferred) from the academic year 1996-97, the most recent year for which data was available, was used. Institutions were included in the regional count according to the following criteria:

1) they conferred degrees of bachelor's or higher; or,
2) they conferred at least 25 associate's degrees.

All institutions that satisfied these criteria were included in the final count for Greater Philadelphia and comparison regions, including instances were multiple branch campuses of the same institution were coded separately in the IPEDS data set (e.g., Widener University-Main Campus and Widener University-Delaware Campus).

Several adjustments were made to the Greater Philadelphia count. Two New Jersey institutions were added to the list – the University of Medicine and Dentistry, Camden Campus & Stratford Campus (counted as one institution) and the New Jersey Institute of Technology, Mt. Laurel. Both these institutions are campuses of New Jersey universities with main campuses in other parts of the state. However, campus-level data was not available for either of these institutions in the IPEDS systems so they are not reflected in other regional measures such as total enrollment or expenditures data. Two other points of clarification: MCP Hahnemann was counted as a separate institution even though Drexel University took over management after the bankruptcy of the Allegheny Health Education and Research Foundation. Also, the Pennsylvania School of Podiatric Medicine was counted as a separate institution, even though it recently has been incorporated into Temple University as the School of Podiatric Medicine.

In several instances Greater Philadelphia is compared to five other regions for a more narrow analysis: 1) Boston-Worcester-Lawrence-Lowell-Brockton, MA-NH NECMA, which is most similar to Philadelphia in age and industry breakdown; 2) Houston-Galveston-Brazoria, TX CMSA, comparable in population size; 3) Pittsburgh, PA MSA, Pennsylvania's other major metropolitan region who can be viewed as an in-state competitor and collaborator; 4) Raleigh-Durham-Chapel Hill, NC MSA, a fast-growing high tech economy that is generally acknowledged as having strong ties to colleges and universities; and, 5) San Francisco-Oakland-San Jose, CA CMSA (i.e., Silicon Valley), unequivocally the focal point of high-tech activity in the country today. All are knowledge industry competitors of Greater Philadelphia, especially in the growing industry of biotechnology.

All regions mentioned in this report are reported as either: 1) the Consolidated Metropolitan Statistical Areas (CMSA); 2) the Metropolitan Statistical Area (MSA); or the New England County Metropolitan Area (NECMA). The US Office of Management and Budget has defined these regional designations according to published standards that are applied to Census Bureau data. In this report, regions are reported as the largest existing geographic designation. If a region is part of a CMSA, it is reported as part of the CMSA. For example, Greater Philadelphia is reported as the Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD CMSA (unless otherwise noted), which is comprised of 14 counties spread out among three Primary Metropolitan Statistical Areas (PMSAs). On the other hand, Pittsburgh, PA, is reported as an MSA because it is not part of a larger CMSA. Unless otherwise noted, rankings cited throughout this report are a comprehensive mixture of CMSAs, MSAs, and NECMAs.

Gross Regional Product

Greater Philadelphia's gross regional product (calculated for the 9-county Philadelphia, PA-NJ region) was estimated by first calculating the percentage of industry employment, at the two-digit level, as a proportion of total state employment in the respective industry (e.g., the number of manufacturing jobs in the MSA as a proportion of total state manufacturing jobs). The percentage was then multiplied by the total gross state product (obtainable from the US Bureau of Economic Analysis) for the respective industry. Once this figure was calculated for each industry, the totals were aggregated to compute a gross regional product. Gross regional product was calculated for two years, 1990 and 1996, and adjusted to reflect real dollars. Average annual growth between 1990 and 1996 is intended to convey a sense of the region's economic value and output. This methodology rests on the assumption that output per employee is uniform statewide.

Estimates of Student Attraction

The total number of students from the 5 Pennsylvania counties of the metropolitan area was estimated using 1997-98 first-time enrollment data provided by the Pennsylvania Department of Education. This report includes data on the original state of residence of students enrolling for the first time in each regional institution. Estimates from New Jersey, Delaware, and Maryland regional institutions were estimated from first-time enrollment data reported by the National Center for Education Statistics. From both these data sets, the percentage of students from Pennsylvania, New Jersey, Delaware, and Maryland were calculated for each institution. The number of students from the 14-county metro area was carved out of the PA/NJ/DE/ME figure according to the following assumptions: 1) private, highly selective schools drew the smallest number of "native" students as a proportion of total institutional enrollment; 2) less selective private schools, state schools, and state-related schools drew a much higher number of native students as a proportion of total institutional enrollment; and, 3) all PA/NJ students of enrolling at community colleges and private, proprietary institutions were assumed to be originally from the region. These estimates were used to determine the number of students who originally were not from the region. Eleven institutions with the greatest number of students coming from outside the region were contacted for feedback on the estimates for the 9-county region. Eight of the 11 institutions provided feedback, which was incorporated into the final estimates.

Regional Strategic Economic Clusters

In 1995, Greater Philadelphia First put forth an economic strategy identifying five industry clusters that present the greatest growth opportunities for the region or are of strategic importance to the region. These five industry clusters represent opportunities not only for regional employment growth, but also for regional economic growth because they are tradable or exportable industries. Growth in these industries draws in dollars from outside the region that boost wages, create more jobs, raise the skill levels of workers, and ultimately generate wealth for the region. The following industries make up the strategic economic clusters:

Professional Services: Engineering and management services; educational services; membership organizations; manufacturing admin. and auxiliary; legal services; computer programming services; computer integrated systems design; advertising; prepackaged software

Hospitality: Eating and drinking places; amusement and recreation services; hotels and other lodging places; museums, botanical, zoological gardens

Data-Intensive Services: Business services; insurance carriers; printing and publishing; depository institutions; insurance agents, brokers, and service; non-depository credit institutions; catalog and mail-order houses

Health Care Services and Products: Health services; drugs; surgical, medical, & dental instruments and support; ophthalmic goods

Manufacturing: precision manufacturing sub-cluster; heavy manufacturing sub-cluster; processing industries sub-cluster; other manufacturing sub-cluster

Estimates of Net Gain/Loss of College-Bound People

First-time freshmen enrollment for 1998-99 was estimated using the growth rate between 1992-93 and 1996-97 of the IPEDS data set. (First-time freshmen enrollment data for 1998-99 is currently not available.) Data on the post-graduation intentions of high school graduates in the Philadelphia region (public and private) for the 19997-98 school year was obtained from the Pennsylvania Department of Education and the *Philadelphia Inquirer's* School Report Card. The post-graduation intentions of New Jersey, Delaware, and Maryland regional high school graduates were estimated using data from the Philadelphia portion of the region. Similar data was obtained for four comparison regions from their respective state Departments of Education, however several could not provide data on private high school graduates. Private school graduates from these regions were estimated based on the ratio of private high school graduates throughout each respective state as reported by the National Center for Education Statistics. No data on the number or post-graduation intentions of high school graduates could be provided for the San Francisco CMSA and therefore this region was excluded from this comparison. The final measure is the difference between the total number of college-bound high school graduates in each region and total first-time freshmen enrollment at regional institutions.

Higher Education Quality Index

The index of higher education quality is a regional indicator that was developed by the *Pittsburgh Post-Gazette* using the *U.S. News & World Report* rankings. The index, which has been expanded from the original *Post-Gazette* measure to include more of the *U.S. News* rankings, grants points to regions based on the number of institutions that appear in the top rankings according to the following criteria:

Graduate & First Professional Programs	Undergraduate Institutions
▪ Top 25 law school – 10 points ▪ Top 25 medical school – 10 points ▪ Top 25 business school – 10 points ▪ Top 25 Engineering Ph.D. program – 3 points ▪ Top 25 Chemistry Ph.D. program – 3 points ▪ Top 25 Physics Ph.D. program – 3 points ▪ Top 25 Biological Sciences program – 3 points ▪ Top 25 Computer Sciences Ph.D. – 3 points	▪ First tier (top 50) national undergraduate university – 8 points ▪ Second tier national undergraduate university – 5 points ▪ Top 40 liberal arts college – 3 points ▪ Third tier national undergraduate university – 1 point ▪ Tier 1 regional undergraduate university – 1 point

This methodology to some degree addresses the most controversial aspect of the *U.S. News* rankings – the claim that the ranking criteria have not been consistent from year to year. This inconsistency has resulted in significant changes in the positions of the top-ranking institutions. In the methodology of the Higher Education Quality Index, points are awarded based on whether or not the institution was top-ranking, as opposed to awarding points based on the actual ranking of each institution.

Faculty Awards

Faculty Awards were assembled by the University of Florida's TheCenter as part of its research on The Top American Research Universities (http://thecenter.ufl.edu/). Data were collected from directories or web-based listings for multiple agencies or organizations on several prominent grant and fellowship programs in the arts, humanities, science, engineering, and health fields. Data were aggregated at the regional level by PEL. Faculty awards included in this measure are:

- American Council of Learned Societies (ACLS) Fellows, 1998-99
- Beckman Young Investigators, 1999
- Burroughs-Wellcome Fund, 1999
- Cottrell Scholars, 1999
- Fulbright American Scholars, 1999-00
- Getty Scholars in Residence, 1999-00
- Guggenheim Fellows, 1999
- Howard Hughes Medical Institute Investigators, 1998-99
- Lasker Medical Research Awards, 1999
- MacArthur Foundation Fellows, 1999
- National Endowment for the Humanities (NEH) Fellows, 1999-00
- National Humanities Center Fellows, 1999-00
- NIH MERIT (R37) and Outstanding Young Investigator (R35), FY 1999
- National Medal of Science and National Medal of Technology, 1999
- Newberry Library Long-term Fellows, 1999-00
- Pew Scholars in Biomedicine, 1999
- Presidential Early Career Awards for Scientists and Engineers (PECASE), 1998
- Robert Wood Johnson Policy Fellows, 1998-99
- Searle Scholars, 1999
- Sloan Research Fellows, 1999
- NSF CAREER awards (excluding those who are also PECASE winners), 1998
- US Secretary of Agriculture Honor Awards, 1999
- Woodrow Wilson Fellows, 1999-00

As noted by TheCenter: "While the vast majority of these programs clearly identify a particular campus, in a few instances we used the institution's web-based phone directory to determine the correct campus."

Estimates of Regional Educational Attainment Level

Regional educational attainment levels were estimated using county figures from the 1990 Census as the base and adjusting them with 1997 national figures from the Census Bureau's Current Population Survey. The underlying assumption of the methodology is that changes in US educational levels and population between 1990 and 1997 were proportional to changes in educational levels and population at the county level over the same period. County estimates were calculated in the following manner: The percentage change in US educational level between 1990 and 1997 was calculated. This figure was then divided by the percentage change in the 25+ population over the same period to obtain a ratio. On the county side, the percentage change in the 25+ population was calculated for the same period. The next step was to solve for the unknown percentage change in educational attainment at the county level and aggregating the county estimates to obtain a regional educational attainment level. These estimates were combined with total student enrollment at regional institutions to come up with a proxy for the pool of skilled and educated workers in the region. The final measure is the ratio of this pool of skilled workers to the regional working age population, defined to be the resident population ages 16 to 64 years.

GREATER PHILADELPHIA'S KNOWLEDGE INDUSTRY

Leveraging the Region's Colleges and Universities in the New Economy

- ✓ The 14-county Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD Consolidated Metropolitan Statistical Area (CMSA) has 83 colleges and universities with combined annual spending of $6.4 billion. (Colleges and universities are defined as institutions conferring at least bachelors degrees or at least 25 associates degrees in an academic year.)
- ✓ Together, these colleges and universities have full-time equivalent[i] (FTE) enrollment of 213,400 (296,000 full- and part-time students), ranking Greater Philadelphia's knowledge industry the 7th largest in the country.
- ✓ An estimated one-quarter of newly enrolled students (between 18,000 and 19,000) come from outside the region to attend school in Greater Philadelphia.
- ✓ In terms of newly enrolled freshmen, there is an estimated net gain of 3,000 college-bound individuals to the region (the difference between the number of college-bound graduates from regional high schools and the number of newly enrolled freshmen at regional colleges and universities).
- ✓ More than 51,000 degrees are conferred each year by Greater Philadelphia's colleges and universities, introducing new knowledge and skills into the potential worker pool. The top-producing majors are in broad-based fields such as business and liberal arts as well as in the health professions, a reflection of the region's strength in the professional services industry as well as the health care services industry.
- ✓ A core group of universities in the region spent almost $666 million in research and development (R&D) in 1998, the 7th largest regional R&D expenditures in the country.
- ✓ Greater Philadelphia institutions' capacity to transfer their research findings into the commercial world has been strengthening – 131 patents were granted to researchers at regional universities (the 5th largest number in the country) and 141 licenses and options were executed by regional universities (the 7th largest number in the

Total Regional FTE Enrollment

1. New York CMSA (703,800)
2. Los Angeles CMSA (535,700)
3. Chicago CMSA (321,600)
4. San Francisco Bay Area CMSA (309,800)
5. Boston NECMA (268,800)
6. Washington-Baltimore CMSA (264,500)
7. **Philadelphia CMSA (213,400)**
8. Detroit CMSA (173,800)
9. Dallas CMSA (137,700)
10. San Diego CMSA (128,400)

Source: PA Economy League (PEL), utilizing National Center for Education Statistics (NCES)

Regional Student Concentration (FTE/1,000 residents)

1. Austin MSA (73)
2. San Diego MSA (46)
3. Boston NECMA (46)
4. San Francisco Bay Area CMSA (46)
5. Denver CMSA (44)
6. Pittsburgh MSA (39)
7. Seattle CMSA (37)
8. Minn/St. Paul MSA (37)
9. Phoenix MSA (37)
10. Chicago CMSA (37)

12. Philadelphia CMSA (35.6)

Source: PEL, utilizing NCES and US Census data.

Top Regions for University R&D Spending (millions)

1. New York CMSA ($1,759)
2. Washington-Baltimore CMSA ($1,583)
3. San Francisco Bay Area CMSA ($1,291)
4. Boston NECMA ($1,216)
5. Los Angeles CMSA ($1,156)
6. Raleigh-Durham MSA ($773)
7. **Philadelphia CMSA ($666)**
8. Chicago CMSA ($654)
9. Detroit CMSA ($645)
10. Houston CMSA ($644)

Source: PEL, using NSF data

country) in fiscal year 1998. Licenses and options executed in fiscal year 1998 represent almost a third of all currently active licenses for regional universities.

Quality Rankings of US Knowledge Regions (PEL Index)

1. New York CMSA (236)
2. Los Angeles CMSA (161)
3. Boston NECMA (152)
4. San Francisco Bay Area CMSA (127)
5. Chicago CMSA (117)
6. Washington-Baltimore CMSA (102)
7. Raleigh-Durham MSA (94)
8. **Philadelphia CMSA (78)**
9. Detroit CMSA (58)
10. Atlanta MSA (44)

Source: PEL, using US News & World Report 2001 rankings of colleges and graduate programs

- ✓ Despite being the 7th largest knowledge industry in the country (in terms of FTE enrollment), the region lags behind in the concentration of students relative to the residential population, which is the 6th largest in the country. Of the 20 largest regional knowledge industries in the country (based on FTE enrollment), Greater Philadelphia ranks 12th in the number of FTEs students per 1,000 regional residents. If Greater Philadelphia drew the same proportion of students as it has of the US population, we would have 20,000 more FTE students than we currently do. Relative to other regions, if we met the concentration of the Boston NECMA region, we would have over 60,000 more FTE students. And from the perspective of pure size, the Philadelphia CMSA would need at least 51,000 more FTE students just to match the next highest ranking region (Washington-Baltimore CMSA).
- ✓ Greater Philadelphia's reputation as a knowledge region is good, but not the best – in an index of higher education quality based on the 2000 rankings issued by *U.S. News & World Report*, the region ranks collectively in 8th place. This ranking is confirmed by other measures, including the number of awards received by faculty and membership to the National Academy of Sciences. Greater Philadelphia's reputation rests squarely on the shoulders of the University of Pennsylvania, which is the only institution in the region that is nationally recognized for overall undergraduate education as well as the three major areas of graduate studies (business, medicine, and law).
- ✓ As compared to other regions, Greater Philadelphia's research capacity lacks diversity in terms of both institutional excellence and fields of study. As seen with the institution rankings, the region's R&D capacity is driven by the University of Pennsylvania, which accounts for 50 percent of R&D expenditures in the region. Furthermore, the vast majority of R&D expenditures in Greater Philadelphia (74 percent) were in the life sciences (medical, biological, and agricultural sciences); no more than 7 percent of regional R&D expenditures went toward any other field of study, including engineering and the physical sciences. Overall, the region's place among the largest in the country is precarious – any slippage in R&D expenditures on our part or significant growth experienced by regions ranked behind Greater Philadelphia could displace the region from the top 10.

[i] FTE enrollment is the sum of all full-time students and 1/3 part-time students.

State and Regional Initiatives Linking Knowledge Industry and Economic Development

- Raleigh-Durham: NC State Centennial Campus ($300M-$2B); North Carolina Biotechnology Center
- San Diego: BIOCom; UC-San Diego Connect
- Detroit/Michigan: Life Sciences Corridor ($1B)
- Pittsburgh: Digital Greenhouse ($13.2 million state investment)
- Baltimore: Johns Hopkins Bay View Research Center
- Boston: Boston university's BioSquare project; Forest City—MIT University Park commercial development in Cambridge
- Illinois: Venture Tech proposal ($1.9 B over 5 years)
- Austin: Microelectronics and Computer Consortium (MCC)
- Atlanta/Georgia: Industries of the Mind Initiative (Atlanta Chamber of Commerce); Georgia Research Alliance; Yammacraw Alliance
- San Francisco Bay Area: Mission Bay development ($1B mixed-use real estate development built around relocation of UC-SF research facilities);Bay Area Sciences Infrastructure Consortium
- Scholarship Programs: California ($1.3 B); Georgia Hope Scholarships; Massachusetts

GREATER PHILADELPHIA'S KNOWLEDGE INDUSTRY

What's currently being done in Greater Philadelphia?

Business/Academic Partnership for IT Workforce
(Greater Philadelphia First):
A consortium of the region's largest employers of information technology (IT) talent formed to develop solutions to the region's growing needs for skilled IT professionals. The Partnership seeks to expand the region's IT workforce through: 1) curriculum and instructional changes in college academic programs; 2) greater awareness and encouragement of IT careers among high school students; and, 3) joint promotion of Greater Philadelphia's companies, career opportunities, and lifestyles to prospective employees.

Campaign to Market Philadelphia as a Technology Center
(TL Ventures, University of Pennsylvania, Greater Philadelphia Chamber of Commerce, Greater Philadelphia Venture Group, Eastern Technology Council):
A $2-million marketing campaign announced on October 25,2000, geared toward raising the profile of the region as a technology center. The campaign will target students and technology publications, with the objective of getting Philadelphia mentioned in national rankings and lists of tech "hotspots."

Centers of Excellence Service Network
(Ben Franklin Technology Partners of Southeastern Pennsylvania):
A BFTP program designed to assist companies in addressing near-term technical needs by utilizing the Philadelphia area research institutions. The Centers provide consulting and use of laboratory facilities for analysis, experimentation, and prototyping in exchange for funding jointly provided by BFTP and the company. Centers of Excellence are currently located at West Chester University, Drexel University, Villanova University, Thomas Jefferson University, and Wistar Institute.

Greater Philadelphia Collegetown Project
(Temple Issues Forum):
A proposed umbrella organization aimed to bring people and ideas together around the general theme of "Collegetown Philadelphia." GPCP recently hosted a conference, "Collegetown Philadelphia: Is This an Idea Whose Time has Come," at the WHYY studios where academic and civic officials discussed the connections between the region's colleges and universities and economic development.

HUBS: Hospitals, Universities, Businesses, and Schools
A public-private initiative sponsored by Congressman Curt Weldon (R-PA) that is creating a specialized and innovative virtual private network between hospitals in the four-state HUBS region (Pennsylvania, New Jersey, Delaware, and Maryland). When complete, the HUBS initiative will allow for the transfer of critical patient information between partner institutions.

Nanotechnology Center
(University of Pennsylvania, Drexel University, Ben Franklin Technology Partners of SEPA):
A virtual research center recently formed with a $10.5 million grant from the Pennsylvania Technology Investment Authority. The Center will act as a clearinghouse of information and ideas between researchers at universities and companies in the field of nanotechnology, with the goal of expediting the commercialization of research establishing

the region as a leader in this emerging life sciences field. Funds will be used to not only sponsor research activities, but to purchase equipment, sponsor symposiums, and leverage federal research dollars. Universities across the region, including those in other states, will be invited to joint the partnership, such as the University of Delaware and Rutgers University.

Onebigcampus.com

(Greater Philadelphia Tourism Marketing Corporation, Campus Visit):
A marketing campaign sponsored by GPTMC and run by Campus Visit, with the overarching goal of extending the overnight stays of visitors to regional campuses. The campaign uses a magazine, website, and toll-free number to help prospective students and parents make travel arrangements in the Philadelphia area for their campus visits.

Student Retention Committee

(City of Philadelphia, Commerce Department):
A committee formed by the City of Philadelphia's Commerce Department initially under the Rendell Administration and still in existence under the Street Administration. The Committee has undertaken numerous initiatives to increase graduate retention in the area, including conducting a promotional campaign ("Philly College Town"), hosting a free concert/job fair for area students, and providing a communications venue for the university, civic, and student communities.

University City District

A partnership of institutions (including three universities – University of Pennsylvania, Drexel University, and University of the Science in Philadelphia), businesses, and communities in University City formed to supplement city maintenance and public safety services. UCD also implements hospitality, promotional, and physical improvement programs to enhance the neighborhood.